

# ACCOUNTS & KEYS TO UPLAND VEGETATION TYPES

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# 1. BRIEF ACCOUNTS

## 1.1. Woodland communities (W3-4, W7, W9, W11, W17-18)

### ***Salix pentandra-Carex rostrata* woodland (W3)**

#### DESCRIPTION

This is wet woodland with a low, grey canopy of willows. *Salix cinerea* and *S. pentandra* are the two most common species, although *S. pentandra* is absent from some stands; there can also be some *Betula pubescens* or *Alnus glutinosa*. In some places the willows are old, gnarled, twisted bushes, grey with lichens and hanging with epiphytic bryophytes. They stand knee-deep in a lush, swampy sward of *Carex rostrata* and tall forbs, such as *Angelica sylvestris*, *Filipendula ulmaria*, *Potentilla palustris* and *Geum rivale*. There is commonly a sprinkling of *Caltha palustris*, its golden flowers lighting up the drab woodland floor in spring. Other small plants grow here too, including *Cardamine pratensis* with its delicate lilac flowers, *Galium palustre*, *Menyanthes trifoliata* and *Valeriana dioica*. Over the wet peat there is a thin weft of mosses, such as *Calliergonella cuspidata*, *Calliergon cordifolium*, *C. giganteum*, *Eurhynchium praelongum* and *Climacium dendroides*.

#### DIFFERENTIATION FROM OTHER COMMUNITIES

*Salix-Carex* woodland resembles *Alnus-Fraxinus-Lysimachia* woodland W7, which is also wet and herb-rich. It most closely resembles the *Carex-Cirsium* sub-community W7b, which is the form of the community on the wettest ground and which can occur under a canopy of willows, especially in the western Highlands and the Hebrides. *Salix-Carex* woodland is wetter and more swampy, with a distinctive field layer of tall, lush poor-fen herbs, and there is more *Carex rostrata*, *Equisetum fluviatile*, *Calliergon giganteum* and *C. cordifolium* than in *Alnus-Fraxinus-Lysimachia* woodland. *Lysimachia nemorum* and *Carex remota* are more common in the latter community.

*Salix-Carex* woodland is similar to the lowland *Salix cinerea-Galium palustre* woodland W1, which also has a field layer including poor-fen herbs. However, *Salix-Carex* woodland is more species-rich, with more *Filipendula ulmaria*, *Caltha palustris*, *Angelica sylvestris*, *Carex rostrata* and *Geum rivale*. These herbs can also grow in *Salix-Galium* woodland, but usually as scattered individuals rather than as lush mixed swards. *Juncus effusus* is more common in the *Salix-Galium* community than in *Salix-Carex* woodland.

#### ECOLOGY

This is woodland of wet basins, ungrazed mires and the edges of fens and open water. The soils are fen peats kept wet by base-rich water. It is most common over base-rich rocks, such as limestone and basalt, usually below about 400 m.

#### DISTRIBUTION

*Salix-Carex* woodland is scarce but widely scattered at low altitudes from north Wales northwards.

There seems to be nothing quite like this form of woodland outside Britain and Ireland, although montane willow scrub in Scandinavia can have a similar ground flora.

### ***Betula pubescens-Molinia caerulea* woodland (W4)**

#### DESCRIPTION

This is wet woodland with a green, grassy, ground flora. *Betula pubescens*, *Alnus glutinosa*, *Salix aurita* and *S. cinerea*, some of them old, distorted and covered with lichens and bryophytes, stand over a lush field layer of *Molinia caerulea*. *Quercus petraea* can grow here too. The mosses *Sphagnum palustre*, *S. fallax* and *Polytrichum commune* grow in rich-green carpets over the soft, wet ground. In the western Highlands and the Inner Hebrides there are scrub forms of *Betula-Molinia* woodland with a canopy of *S. aurita* or *S. cinerea* or both, but no larger trees.

There are three sub-communities, which correspond with variation in the wetness of the soil. The *Dryopteris dilatata-Rubus fruticosus* sub-community W4a is the driest type, with *Dryopteris dilatata*, *Rubus fruticosus* and *Lonicera periclymenum*. The *Juncus effusus* sub-community W4b has a moderately rich assortment of vascular species, including *Juncus effusus*, *J. acutiflorus*, *Holcus mollis*, *H. lanatus*, *Deschampsia cespitosa*, *Potentilla erecta*, *Viola palustris* and *Cirsium palustre*. The *Sphagnum* sub-community W4c occurs on the wettest soils. It

has sheets of *Sphagnum fallax* and *S. palustre*, and rather less *S. fimbriatum*, *S. papillosum* and *S. squarrosum*. A few bog species, such as *Erica tetralix*, *Calluna vulgaris*, *Eriophorum angustifolium* and *E. vaginatum*, may also grow here. There is also a species-poor form of *Betula-Molinia* woodland with little more than *Molinia* and *Potentilla erecta* under the trees. This does not fit any of the sub-communities described in the NVC.

#### DIFFERENTIATION FROM OTHER COMMUNITIES

In no other woodland type are *Molinia*, *Sphagnum* species and *Polytrichum commune* as common as in the *Betula-Molinia* community. *Quercus-Betula-Oxalis* W11 and *Quercus-Betula-Dicranum* W17 woodlands are drier and generally have little *Sphagnum*, although *S. quinquefarium* is locally common in some stands of the latter community. *Salix-Carex* woodland W3 and *Alnus-Fraxinus-Lysimachia* woodland W7 are more herb-rich, with little or no *Molinia* and *Sphagnum*. Willow scrub forms of *Betula-Molinia* woodland have more *Salix aurita*, *Molinia* and *Sphagnum* and fewer herbs than the lowland *Salix cinerea-Galium palustre* woodland W1.

#### ECOLOGY

The community is common on flushed slopes, in poorly-drained gullies and valley bottoms, and in hollows with impeded drainage. It commonly forms small patches among other types of woodland, especially *Quercus-Betula-Oxalis* and *Quercus-Betula-Dicranum* woodlands. The species-poor form can occur in large stands. *Betula-Molinia* woodland is the counterpart of *Alnus-Fraxinus-Lysimachia* woodland on acid soils, and the soils are wet, moderately acid peats. On adjacent open ground it can grade into mires, heaths and grasslands, especially *Molinia-Potentilla* mire M25 and *Trichophorum-Erica* wet heath M15.

#### DISTRIBUTION

*Betula-Molinia* woodland is common throughout most of upland Britain, especially in the wet climate of north Wales, the Lake District and western Scotland. It is also widespread but scarce in the lowlands. The *Juncus* sub-community is one of the most common types of woodland in the uplands.

There are similar wet woodlands in mainland Europe.

### ***Alnus glutinosa-Fraxinus excelsior-Lysimachia nemorum* woodland (W7)**

#### DESCRIPTION

This is wet, herb-rich woodland. The canopy can vary dramatically from dwarfed *Salix aurita* barely more than one or two metres tall, through hazel coppice and birch scrub, to tall ash and alder trees; *Alnus glutinosa*, *Betula pubescens*, *Fraxinus excelsior*, *Quercus petraea*, *Sorbus aucuparia*, *Salix aurita*, *S. cinerea*, *S. caprea* and *Corylus avellana* have all been recorded here either as the sole species in the canopy or in mixtures. Many stands are moribund with a single layer of old trees and little or no regeneration. There is a green, grassy, herb-rich field layer of species such as *Lysimachia nemorum*, *Filipendula ulmaria*, *Athyrium filix-femina*, *Holcus mollis* and *Poa trivialis*. The field layer can be short or lush, depending on grazing levels. There is a tangled mat of bryophytes over the woodland floor, made up of species such as *Eurhynchium praelongum*, *Plagiomnium undulatum*, *Calliergonella cuspidata*, *Brachythecium rutabulum* and *B. rivulare*. In some places, especially in the western Highlands, there are scrub forms of *Alnus-Fraxinus-Lysimachia* woodland with a low canopy of *S. aurita* or *S. cinerea* or both.

There are three sub-communities. The *Urtica dioica* sub-community W7a is the more lowland type, and is characterised by carpets of *Chrysosplenium oppositifolium* and *Ranunculus repens*, commonly beneath a lush growth of *Urtica dioica*, *Galium aparine* and *Angelica sylvestris*. *Phalaris arundinacea*, *Oenanthe crocata* and *Iris pseudacorus* are common in some western stands. The *Carex remota-Cirsium palustre* sub-community W7b occurs on the most permanently waterlogged soils, and has a rich mixture of herbs, including *Cirsium palustre*, *Valeriana officinalis* and *Crepis paludosa*. *Carex remota* is common, and *C. laevigata* and *C. pendula* can also occur. The *Deschampsia cespitosa* sub-community W7c occurs on drier soils. *Deschampsia cespitosa* is especially common here, together with *Anthoxanthum odoratum*, *Agrostis capillaris*, *Oxalis acetosella*, *Dryopteris dilatata* and *D. affinis*.

#### DIFFERENTIATION FROM OTHER COMMUNITIES

The most similar types of upland woodland are *Betula-Molinia* W4, *Quercus-Betula-Oxalis* W11 and *Fraxinus-Sorbus-Mercurialis* W9. Neither of the first two communities has as many herbs as *Alnus-Fraxinus-Lysimachia* woodland. *Betula-Molinia* woodland has more *Molinia caerulea*, Sphagna and *Polytrichum commune*, and *Quercus-Betula-Oxalis* woodland is drier with more grasses and bracken. *Fraxinus-Sorbus-Mercurialis* woodlands are herb-rich but occupy drier soils and have more *Oxalis acetosella*, *Viola riviniana*, *Mercurialis perennis* and the moss *Eurhynchium striatum*. Willow scrub forms of *Alnus-Fraxinus-Lysimachia* woodland with a canopy of *Salix*

*cinerea* or *S. aurita* can resemble the lowland *Salix cinerea-Galium palustre* woodland W1, but their ground flora usually includes *Filipendula ulmaria*, *Lysimachia nemorum*, *Athyrium filix-femina*, *Dryopteris dilatata* and the mosses *Eurhynchium praelongum*, *Brachythecium rivulare* and *Calliergonella cuspidata*. Because of their ground flora, these types of willow scrub are better classed as forms of *Alnus-Fraxinus-Lysimachia* woodland than as either *Salix-Galium* woodland or willow scrub forms of the *Betula-Molinia* community.

#### ECOLOGY

These are woodlands of flushed slopes, valleys and streamsides throughout the upland fringes. The underlying rocks may be either acid or basic, but the soils are wet brown earths with a neutral pH. The community occurs either as pure stands or as patches within other types of woodland, especially *Quercus-Betula-Oxalis* woodland and *Fraxinus-Sorbus-Mercurialis* woodland.

#### DISTRIBUTION

The community is widespread and common at low altitudes throughout the British uplands with outliers in the lowlands of southern England. It is scarce in the far north of Scotland. Scrubby stands with a canopy of *Salix aurita*, *S. cinerea* or *Corylus avellana* are particularly common in the Inner Hebrides.

There are similar woods in mainland Europe.

### ***Fraxinus excelsior-Sorbus aucuparia-Mercurialis perennis* woodland (W9)**

#### DESCRIPTION

These are herb-rich woodlands on fairly dry to moist soils. Beneath a canopy of *Fraxinus excelsior*, *Ulmus glabra*, *Sorbus aucuparia*, *Betula pubescens*, *Corylus avellana* and in some places *Quercus petraea* there is a lush field layer of *Mercurialis perennis*, *Sanicula europaea*, *Urtica dioica*, *Brachypodium sylvaticum*, *Oxalis acetosella*, *Viola riviniana*, *Primula vulgaris*, *Filipendula ulmaria* and *Deschampsia cespitosa*. The ferns *Athyrium filix-femina*, *Dryopteris filix-mas*, *D. affinis* and *D. dilatata* are common. There are many bryophytes too, including *Eurhynchium praelongum*, *E. striatum*, *Plagiomnium undulatum* and *Thuidium tamariscinum*. In north-western Scottish stands, where the climate is cool and humid and there is little atmospheric pollution, the trees can be almost totally covered with epiphytes, including lichens of the *Lobarion pulmonariae* and *Graphidion scriptae* alliances and many oceanic bryophytes. Some stands, especially in western Scotland, have a canopy dominated by hazel, with few or no taller trees.

There are two sub-communities. The Typical sub-community W9a is the more widespread type, and has *Geum urbanum*, *Circaea lutetiana* and *Dryopteris dilatata* in the field layer. The *Crepis paludosa* sub-community W9b has a more restricted and decidedly upland distribution. Here *G. urbanum* is generally replaced by *G. rivale*, and this, together with other characteristic species, such as *Crepis paludosa*, *Deschampsia cespitosa*, *Cirsium heterophyllum* and *Geranium sylvaticum*, shows the influence of cooler, damper conditions.

#### DIFFERENTIATION FROM OTHER COMMUNITIES

*Quercus-Betula-Oxalis* woodland W11 is grassier than *Fraxinus-Sorbus-Mercurialis* woodland, with less ash, more oak and birch, and fewer tall herbs, such as *Mercurialis perennis* and *Sanicula europaea*. *Alnus-Fraxinus-Lysimachia* woodland W7 is wetter than *Fraxinus-Sorbus-Mercurialis* woodland, and has more *Lysimachia nemorum*, *Cirsium palustre*, *Carex remota*, *Chrysosplenium oppositifolium* and wetland mosses, such as *Brachythecium rivulare*, *Calliergonella cuspidata* and *Rhizomnium punctatum*. *Fraxinus excelsior-Acer campestre-Mercurialis perennis* woodland W8 is the lowland counterpart of this community. Its flora is very variable and can be quite similar to that of the Typical sub-community of *Fraxinus-Sorbus-Mercurialis* woodland but there is usually less *Oxalis acetosella* and fewer bryophytes, lichens and ferns.

#### ECOLOGY

The soils under *Fraxinus-Sorbus-Mercurialis* woodland are moist or rather dry fertile brown earths derived from base-rich rocks, such as Moine schist, limestone and basalt. Most stands are on steep slopes or in ravines. The uneven, irregular topography of these habitats gives rise to a complicated mixture of soil conditions and hence a diverse ground flora, with *Fraxinus-Sorbus-Mercurialis* woodland commonly forming mosaics with other types of woodland, such as the *Alnus-Fraxinus-Lysimachia* and *Quercus-Betula-Oxalis* communities. *Fraxinus-Sorbus-Mercurialis* vegetation is the characteristic woodland of limestone pavements in the uplands.

#### DISTRIBUTION

The community is widely distributed through the British uplands from Dartmoor to Sutherland, but has not been recorded on the Outer Hebrides, Orkney or Shetland. The wetter *Crepis* sub-community is distinctly northern.

There is related vegetation in Ireland, Norway and Sweden.

### ***Quercus petraea*-*Betula pubescens*-*Oxalis acetosella* woodland (W11)**

#### DESCRIPTION

These are dry woodlands with a grassy ground flora. The canopy is made up of *Betula pubescens*, *B. pendula*, *Quercus petraea*, *Q. robur* and *Sorbus aucuparia*. There can be a shrub layer in which *Corylus avellana* is usually the most common species; some stands are dominated by hazel, with few or no larger trees. *Ilex aquifolium* can be common too, especially in the west of Scotland. The birches and oaks vary from tall and straight to low and twisted. They can have dense growths of bryophytes and lichens on their trunks and lower branches. In some stands the oaks and hazels are coppiced. The field layer is generally made up of *Agrostis capillaris*, *Holcus mollis*, *Anthoxanthum odoratum* and other grasses, together with small forbs, such as *Oxalis acetosella*, *Potentilla erecta* and *Viola riviniana*. *Pteridium aquilinum* can be very common. Dwarf shrubs are rare. There are a great many bryophytes, especially *Thuidium tamariscinum*, *Hylocomium splendens*, *Rhytidiadelphus squarrosus*, *Scleropodium purum*, *Polytrichum formosum* and other large mosses.

Four sub-communities are described in the NVC. In the *Dryopteris dilatata* sub-community W11a at least one of *Dryopteris dilatata*, *Rubus fruticosus* and *Lonicera periclymenum* predominates in a rather tall, untidy field layer which is either lightly grazed or ungrazed; *Hyacinthoides non-scripta* is common here. *Blechnum spicant* does indeed grow in the *Blechnum spicant* sub-community W11b, but just as characteristic here are *Primula vulgaris*, *H. non-scripta* and the moss *Hylocomium brevirostre*. Rocks and the trunks and branches of trees can support rich assemblages of bryophytes and lichens. The *Anemone nemorosa* sub-community W11c has a noticeably northern and more Scandinavian appearance, with much *Rhytidiadelphus triquetrus*, and, scattered among the grasses and mosses, *Anemone nemorosa*, *Luzula pilosa* and *Trientalis europaea*. The *Stellaria holostea*-*Hypericum pulchrum* sub-community W11d is the least distinctive sub-community. Among the grasses are a few forbs, including *Stellaria holostea*, *Hypericum pulchrum*, *Veronica chamaedrys* and *V. officinalis*; *H. non-scripta* is locally common.

Throughout upland Britain there are many stands of *Quercus*-*Betula*-*Oxalis* woodland that are very species-poor, with a field layer of *Agrostis capillaris*, *Anthoxanthum odoratum* and *Holcus* species. Some of these stands are of young trees colonising what was once grassland; others are older woods that have suffered from heavy grazing. These impoverished, grass-dominated stands do not fit into any of the recognised sub-communities. There are also stands of oak or birch woodland with a ground flora of little more than *Luzula sylvatica* which are not described in the NVC, although they vary enough to have affinities with several NVC types. Stands with neither dwarf shrubs nor extensive carpets of mosses are best regarded as forms of *Quercus*-*Betula*-*Oxalis* woodland.

#### DIFFERENTIATION FROM OTHER COMMUNITIES

*Quercus*-*Betula*-*Oxalis* woodland has fewer dwarf shrubs and bryophytes, and more grasses, than *Quercus*-*Betula*-*Dicranum* woodland W17. It is more grassy and less herb-rich than either *Alnus*-*Fraxinus*-*Lysimachia* W7 or *Fraxinus*-*Sorbus*-*Mercurialis* W9 woodland. It is drier than *Betula*-*Molinia* woodland W4, with less *Molinia caerulea*, Sphagna and *Polytrichum commune*. The lowland *Quercus robur*-*Pteridium aquilinum*-*Rubus fruticosus* woodland W10 may closely resemble *Quercus*-*Betula*-*Oxalis* woodland, but can generally be distinguished by the scarcity of *Agrostis capillaris*, *Anthoxanthum odoratum*, *Deschampsia flexuosa*, *Oxalis acetosella*, *Potentilla erecta* and *Viola riviniana*.

#### ECOLOGY

This is woodland of free-draining acid soils on the upland margins, generally below 400 m. Some woods are comprised of pure stands of *Quercus*-*Betula*-*Oxalis* woodland, but the community more commonly occurs in mosaics with other types of woodland. It gives way to *Quercus*-*Betula*-*Dicranum* woodland on steep rocky slopes, and to *Betula*-*Molinia* woodland in wet hollows and gullies and on level waterlogged ground.

#### DISTRIBUTION

The community occurs throughout the British uplands from south-west England to north-west Scotland. It has a western distribution in England and Wales but not in Scotland, where it extends far to the east. The sub-communities have distinctive distributions: the *Dryopteris* sub-community is south-western, the *Blechnum* sub-community is north-western, the *Anemone* sub-community is north-eastern, and the *Stellaria*-*Hypericum* sub-community and the species-poor grassy form of the community are widespread. The form of *Quercus*-*Betula*-*Oxalis* woodland that is dominated by *Luzula sylvatica* occurs in ungrazed or lightly grazed situations, mainly from north Wales northwards.

There are similar grassy birchwoods in the western parts of mainland Europe, but there is probably nothing like the *Blechnum* sub-community outside Britain and Ireland.

### ***Quercus petraea*-*Betula pubescens*-*Dicranum majus* woodland (W17)**

#### DESCRIPTION

This community includes heathy and mossy woodlands with a canopy of *Quercus petraea* and *Betula pubescens* dotted with *Sorbus aucuparia* and, in some places, *Ilex aquifolium*. If there is a shrub layer at all it is just a thin understorey of *Corylus avellana* and young specimens of the canopy trees. Dwarf shrubs predominate in the field layer: dark, shaggy *Calluna vulgaris* or dense, green mats of *Vaccinium myrtillus*. More distinctively, there are great quantities of bryophytes, growing in variegated mats and patches over the ground, covering stumps and boulders, and muffling the bases of trees. The most common species are the mosses *Hylocomium splendens*, *Rhytidiadelphus loreus*, *Pleurozium schreberi*, *Plagiothecium undulatum*, *Thuidium tamariscinum*, *Polytrichum formosum*, *Dicranum majus* and *D. scoparium*.

There are four sub-communities. The *Isothecium myosuroides*-*Diplophyllum albicans* sub-community W17a occurs on the steepest and most rocky ground, including cliff ledges and the sides of deep ravines. It has the richest bryophyte flora, including oceanic liverworts, such as *Scapania gracilis* and *Plagiochila spinulosa*. The oceanic filmy ferns *Hymenophyllum wilsonii* and *H. tunbrigense* also occur here. The Typical sub-community W17b is very heathy, with a thick field layer of heather or bilberry or both, but otherwise has no special distinguishing species. The *Anthoxanthum odoratum*-*Agrostis capillaris* sub-community W17c is grassier than the others, and there can be few or even no dwarf shrubs, but there is still a rich array of bryophytes growing in extensive carpets. In the *Rhytidiadelphus triquetrus* sub-community W17d, the crowded thick shoots of *Rhytidiadelphus triquetrus* with their broad, pale-green leaves are commonly mixed with the more slender *Scleropodium purum* among *Calluna*. *Juniperus communis* ssp. *communis* can form a shrub layer in this sub-community.

There are also stands of birch and oak woodland where the field layer is an almost pure sward of *Luzula sylvatica* interspersed with a few dwarf shrubs and entwined with mosses. These clearly have an affinity with *Quercus*-*Betula*-*Dicranum* woodland.

#### DIFFERENTIATION FROM OTHER COMMUNITIES

*Quercus*-*Betula*-*Dicranum* woodland is separated from other types of deciduous woodland by its mossy and heathy ground flora. Dwarf shrubs can be scarce in the *Anthoxanthum*-*Agrostis* sub-community and some forms of the *Isothecium*-*Diplophyllum* sub-community, but in such places the vegetation can be distinguished from *Quercus*-*Betula*-*Oxalis* woodland W11 by the luxuriance and diversity of mosses and liverworts. The more lowland *Vaccinium myrtillus*-*Dryopteris dilatata* sub-community of *Quercus* species-*Betula* species-*Deschampsia flexuosa* woodland W16b has much *Vaccinium* but is less mossy than *Quercus*-*Betula*-*Dicranum* woodland. *Pinus*-*Hylocomium* woodland W18 has a heathy and mossy ground flora similar to that in this community, but has a canopy of pine instead of deciduous trees.

#### ECOLOGY

This is the characteristic upland woodland of steep, rocky hillsides on thin, moist, free-draining acid mineral soils. The underlying rocks are usually hard and acid, and include granite, Pre-Cambrian sandstone and gneiss, Dalradian schist, Ordovician and Silurian slate and shale, and Carboniferous Millstone Grit. Most stands are below 450 m, but *Quercus*-*Betula*-*Dicranum* woodland extends up to almost 700 m on a few sheltered slopes in the western Highlands. It generally replaces *Quercus*-*Betula*-*Oxalis* woodland on thinner and more acid soils, on steeper, rockier slopes, and at higher altitudes.

#### DISTRIBUTION

*Quercus*-*Betula*-*Dicranum* woodland occurs throughout the British uplands from Dartmoor to Sutherland. It is particularly common in north Wales and in the Scottish Highlands. The sub-communities have varying distributions: the Typical and *Anthoxanthum*-*Agrostis* sub-communities are widespread, the *Isothecium*-*Diplophyllum* sub-community is western, and the *Rhytidiadelphus* sub-community is north-eastern. Mossy oak-birch woodland with a ground flora dominated by *Luzula sylvatica* has been recorded in lightly-grazed places from north Wales northwards.

There are woodlands resembling this community elsewhere in Europe. Woodland similar to the *Isoethecium-Diplophyllum* sub-community occurs in the west of Ireland, where the bryophyte flora can be just as rich as in the western Highlands (e.g. Ratcliffe 1968, Mitchell and Averis 1988).

### ***Pinus sylvestris*-*Hylocomium splendens* woodland (W18)**

#### DESCRIPTION

These are woods with a canopy of *Pinus sylvestris*: tall, spreading, stately trees with red-brown or grey-brown bark and dense, dark-blue-green needles; they have clean stems, usually without a great growth of bryophytes, but can be well covered with small grey lichens, such as *Hypogymnia physodes*, *Bryoria fuscescens* and *Platismatia glauca*. Many woods are almost pure pine, although there can be a little *Betula pubescens*, *B. pendula*, *Sorbus aucuparia*, *Populus tremula* and *Ilex aquifolium*. In some stands there is a shrub layer of *Juniperus communis* ssp. *communis*, especially in the eastern Highlands. *Calluna vulgaris*, *Vaccinium myrtillus* and *V. vitis-idaea* are the most conspicuous species in the field layer, and are accompanied by *Deschampsia flexuosa*. There are big hummocks and cushions of mosses, mainly large common species, such as *Pleurozium schreberi*, *Rhytidiadelphus loreus*, *Hylocomium splendens*, *Plagiothecium undulatum* and *Dicranum scoparium*.

There are five sub-communities: the first three are characteristic of dry situations and the last two occur on damper ground. The *Erica cinerea*-*Goodyera repens* sub-community W18a occurs in both semi-natural and plantation pinewoods. *Erica cinerea* is common, though it rarely grows thickly, and *Vaccinium myrtillus* and *V. vitis-idaea* are rare or absent. The pinewood orchid *Goodyera repens* grows here, its slender spikes of cream-white flowers enlivening the dark woodland floor. The *Vaccinium myrtillus*-*Vaccinium vitis-idaea* sub-community W18b is the typical form of dry pinewood. There is a dense green layer of *Vaccinium* species under the trees but other than this there are no special distinguishing species. The *Luzula pilosa* sub-community W18c is another dry woodland, characterised by *Luzula pilosa*, *Galium saxatile* and *Oxalis acetosella*. The *Sphagnum capillifolium*/*quinquefarium*-*Erica tetralix* sub-community W18d is the typical form of damp pinewood. Very characteristic here are the wine-red and bright-green cushions of *Sphagnum capillifolium* and *S. quinquefarium*, and there can also be some *Erica tetralix* and *Molinia caerulea* among the *Calluna* and *Vaccinium* species. The *Scapania gracilis* sub-community W18e resembles the *Sphagnum*-*Erica* sub-community but has patches of the liverworts *Scapania gracilis* and *Anastrepta orcadensis* among the carpets of Sphagna and other mosses.

*Molinia* can grow rather sparsely in the *Sphagnum*-*Erica* sub-community but is dominant in the field layer of some other forms of pine woodland; such stands do not fit anywhere in the NVC (Rodwell *et al.* 1998). Locally, in north-eastern Scotland, there are open pine plantations in which the ground vegetation is conspicuously frosted with large, whitish-cream lichens of the genus *Cladonia* (Watson and Birse 1990; Dargie 1994; Gilbert 2000). This vegetation, which resembles some of the more continental European pine woodlands, cannot be classed within *Pinus-Hylocomium* woodland as currently circumscribed, and may even warrant a separate NVC community (Rodwell *et al.* 1998).

#### DIFFERENTIATION FROM OTHER COMMUNITIES

Only in the *Quercus*-*Betula*-*Dicranum* woodland W17 do the field and ground layers resemble those of *Pinus-Hylocomium* woodland, but this has a canopy of birch or oak with at most only a little pine. Apart from the more heathy examples of *Juniperus-Oxalis* woodland W19a, which are dominated by juniper with little or no pine, there are no other types of British woodland that can be confused with *Pinus-Hylocomium* woodland. The field and ground layers of this type of woodland have much in common with *Calluna-Vaccinium* H12, *Vaccinium-Deschampsia* H18 and *Calluna-Vaccinium-Sphagnum* H21 heaths. In open pine woodland the spatial and floristic boundaries between *Pinus-Hylocomium* woodland and these heaths can be very diffuse.

#### ECOLOGY

This is a community of impoverished, podsolised, acid, free-draining soils. It commonly occurs on sandy or gravelly fluvio-glacial deposits or directly over base-poor metamorphic or sedimentary rocks, such as quartzite or sandstone. The soils may be dry or damp; most of the wetter stands are in the west. The maximum altitudinal limit at present is 640 m on Creag Fhiaclach in the western Cairngorms (Nethersole-Thompson and Watson 1981). Elsewhere in the Cairngorms, the upper limit of the woods appears to have been lowered by land use and management (Pearsall 1968), and the general maximum altitude attained by *Pinus-Hylocomium* woodland is around 500-550 m. In the western Highlands, it is mostly below 300 m. *Pinus-Hylocomium* woodland accounts for some of the largest expanses of native woodland in Scotland, but there are also many very small stands of the community scattered among heathland or forming mosaics with birch woodland.

#### DISTRIBUTION

*Pinus-Hylocomium* woodland is locally common in the Scottish Highlands. It is absent from the extreme north, the extreme south-west and the Hebrides. The *Erica-Goodyera*, *Vaccinium* and *Luzula* sub-communities are recorded mainly in the east, and the *Sphagnum-Erica* and *Scapania* sub-communities are western. The largest and best-known stands are in the eastern Highlands, in the straths and glens of the Spey and the Dee either side of the Cairngorms, where the *Vaccinium* sub-community predominates. There are some large stands further west too: in Glen Affric and Glen Cannich in Inverness-shire, and around Shieldaig and Beinn Eighe in Wester Ross. In the south-west, there are some fine stands in the Black Wood of Rannoch and near Tyndrum. A few planted stands of pine woodland south of the Highlands have also been classed as *Pinus-Hylocomium* woodland (Rodwell 1991a).

Pine woodland similar to this community occurs in western Norway.

## 1.2. Scrub communities (W19-20, W23, W25)

### *Juniperus communis* ssp. *communis*-*Oxalis acetosella* woodland (W19)

#### DESCRIPTION

These shaggy, uneven, dark-glaucous-green stands of scrub are dominated by *Juniperus communis* ssp. *communis* with its twisting spires of branches and its astonishing diversity of form, ranging from flat, spreading bushes to tall, columnar specimens. Accompanying the juniper there can be scattered trees of *Betula pendula*, *B. pubescens* or *Sorbus aucuparia*. *Rosa canina*, *Sambucus nigra*, *Prunus spinosa*, *P. padus* and other shrubs can make a small contribution to the canopy.

There are two sub-communities: one with a heathy ground flora and one with a grassy, herb-rich ground flora. The *Vaccinium vitis-idaea*-*Deschampsia flexuosa* sub-community W19a takes in heathy stands on acid soils. Under the juniper bushes there is a thick layer of dwarf shrubs, comprising *Calluna vulgaris*, *Vaccinium myrtillus* and *V. vitis-idaea*, interleaved with *Deschampsia flexuosa*, *Agrostis capillaris* and *A. canina*. The ground is carpeted with a deep layer of mosses: generally large common species, such as *Hylocomium splendens*, *Thuidium tamariscinum*, *Plagiothecium undulatum*, *Rhytidiadelphus loreus* and *Pleurozium schreberi*. In contrast, the field layer of the *Viola riviniana*-*Anemone nemorosa* sub-community W19b includes *Festuca ovina*, *F. rubra*, *Holcus lanatus*, *Anthoxanthum odoratum*, *Urtica dioica*, *Poa trivialis* and *Veronica chamaedrys*, as well as *Viola riviniana* and *Anemone nemorosa*. There can be lush patches of ferns, including *Gymnocarpium dryopteris*, *Phegopteris connectilis* and *Oreopteris limbosperma*, and *Pyrola media* is locally common. Under these plants is a loose weft of mosses, including *Eurhynchium praelongum*, *Brachythecium rutabulum*, *Hypnum cupressiforme* s.l. and *Plagiomnium undulatum*.

#### DIFFERENTIATION FROM OTHER COMMUNITIES

*Juniperus-Oxalis* scrub is distinguished by the dominance of juniper in the canopy. Many stands of the community contain scattered birch or pine, and woodlands containing mixtures of birch and juniper, or pine and juniper, are widespread; these are transitional between *Juniperus-Oxalis* woodland and *Quercus-Betula-Oxalis* W11, *Quercus-Betula-Dicranum* W17 or *Pinus-Hylocomium* W18 woodlands. Typical stands of these three communities have at most only an open shrub layer of juniper that is clearly subordinate to birch or pine.

#### ECOLOGY

*Juniperus-Oxalis* woodlands occur at moderate to high altitudes between 200 m and 650 m on a variety of rocks from mica-schist and limestone to granite. The soils are free-draining and moist with a fast turnover of nutrients. There is a slight preference for damp hollows and for north-facing slopes where the soils are moister (McVean and Ratcliffe 1962).

Many stands of *Juniperus-Oxalis* woodland may be relict understoreys of woods where birch and pine regeneration has been prevented by grazing (Tidswell 1988; Rodwell 1991a). In many places there are scattered birches among the juniper, for example in parts of the Morrone Birkwood in eastern Scotland and on Birk Fell in the Lake District. In the more natural woodlands of Norway there is juniper scrub at the upper altitudinal limit of pine and birch woodland and in clearings; the field layer can be dominated by grasses, forbs and ferns in mixtures similar to those in the *Viola-Anemone* sub-community. The only good British example of juniper replacing pine at the altitudinal limit of woodland is on Creag Fhiaclach in the Cairngorms at about 600 m. Here it may be natural climax scrub rather than a remnant of more complex woodland. Other stands of juniper scrub have been recorded at around this altitude in the eastern Highlands and they too could be natural.

#### DISTRIBUTION

This is a northern and boreal community of northern England and eastern Scotland, with a few outliers in western Scotland. It is most common and extensive in the eastern Highlands (e.g. Tidswell 1988) and in parts of the Lammermuir Hills, the Lake District and Upper Teesdale.

There is related vegetation in western Norway.

### *Salix lapponum*-*Luzula sylvatica* scrub (W20)

#### DESCRIPTION

This rare and fragmented vegetation is one of the last refuges of scarce montane willows. The willows grow together in a low, scrubby, silvery canopy. *Salix lapponum* and *S. arbuscula* are the most common species, but *S.*

*lanata*, *S. myrsinites*, *S. cinerea*, *S. phylicifolia* or *S. reticulata* can also occur, either in mixtures or as pure stands. In the larger examples there can be a bewildering array of hybrids. The plants grow low and twisted, many clinging precariously to steep, shelving rock ledges streaming with water, their roots clamped to the rocks. Under the willows a great profusion of other plants clothes the ledges and spills over the cliff faces.

Although no sub-communities of *Salix-Luzula* scrub are described in the NVC, there are at least three distinct forms of montane willow scrub (e.g. Averis and Averis 1999a). One is a community of more acid soils, with a green carpet of *Vaccinium myrtillus*, *V. uliginosum*, *Deschampsia cespitosa*, *Luzula sylvatica*, *Dryopteris dilatata* and *Blechnum spicant*; it resembles a *Luzula-Vaccinium* tall-herb community U16 growing under a canopy of willow. The second is a low scrub of *S. myrsinites* growing over limestone outcrops at low to moderate altitudes; this has been recorded at Inchnadamph in Sutherland, at Rassal Ashwood in Wester Ross and on Meall Mór on the south side of Glen Coe in Argyll. No other willows occur. Some examples have a rich understorey of tall herbs and ferns; in others the sward is open and sparse. The third type is the most common, and resembles *Luzula-Geum* tall-herb vegetation U17 but with willows. It can be an almost unbelievably rich assemblage of tall herbs and ferns, the most common of which are *Alchemilla glabra*, *Angelica sylvestris*, *Geum rivale*, *Luzula sylvatica*, *Sedum rosea*, *Filipendula ulmaria*, *Ranunculus acris* and, in stands south of the Great Glen, *Geranium sylvaticum*. The herbs flourish out of the reach of sheep and deer and are bright with flowers in summer. There are usually great mats of mosses and liverworts under the shrubs and herbs; the most common species are big pleurocarpous mosses, such as *Hylocomium splendens*, *Rhytidiadelphus loreus*, *Pleurozium schreberi* and *Thuidium tamariscinum*, and a few widespread calcicoles, such as *Neckera crispa* and *Ctenidium molluscum*.

#### DIFFERENTIATION FROM OTHER COMMUNITIES

*Salix lapponum*, *S. arbuscula* and, less commonly, the other montane willows can grow in stands of the *Luzula-Vaccinium* and *Luzula-Geum* tall-herb communities, as well as in montane *Dryas-Silene* heath CG14, but only in *Salix-Luzula* scrub do they form a continuous canopy. Montane willows can also occur very sparsely in *Carex-Pinguicula* mire M10 and *Carex-Saxifraga* mire M11, but here the ground flora consists of sedges, small forbs and bryophytes, with fewer tall herbs.

#### ECOLOGY

*Salix-Luzula* scrub occurs on steep, rocky ground which is either inaccessible or difficult for grazing animals to reach. Most examples are on rock ledges, crags, or rock outcrops in ravines; there are a few stands in boulder fields. This is a climax community occurring at high altitude (generally above 600 m) in a harsh climate. Most stands are on wet base-rich soils over Moine or Dalradian schist, but a few examples occur on more acid substrates (Rodwell 1991a), and *Salix myrsinites* scrub is mainly in well-drained situations on limestone. The willows can grow on slopes of all aspects, but they flourish particularly well on slopes facing north or east, where the soils are cooler and wetter and where snow lies late in spring. Although extant stands are almost all on inaccessible rocky ground, such as cliff ledges, ravine sides and boulder fields, these are unlikely to be the only natural habitats of *Salix-Luzula* scrub in Britain. Willow scrub would almost certainly once have spread more widely over flushed slopes that now support herb-rich grasslands and mires.

#### DISTRIBUTION

The distribution of *Salix-Luzula* scrub is centred on the base-rich band of Dalradian rocks that runs across the southern Highlands from Ben Lui in the west to Caenlochan in the east. Even here it is rare. The largest stand remaining in Scotland is in Coire Sharrock in Glen Clova in Angus, where it covers about half a hectare of a steep, rocky slope. There is also montane willow scrub on the south side of Glen Coe in Argyll, in the hills around Glens Affric, Cannich and Strathfarrar in Inverness-shire, in the Cairngorms and the Drumochter hills, around Beinn Dearg at the head of Loch Broom, around Rassal in Wester Ross, and on Ben More Assynt and Ben Hope in Sutherland. Fragmentary outliers occur in the Moffat Hills in the Southern Uplands (not shown on the map). *Salix lapponum* grows on the cliffs of Helvellyn in the Lake District, although not in this type of scrub.

There is similar vegetation in Scandinavia and related forms of willow scrub occur in the Alps.

### ***Ulex europaeus-Rubus fruticosus* scrub (W23)**

#### DESCRIPTION

This scrub is dominated by *Ulex europaeus* with its dark-green, spiny shoots and golden, coconut-scented flowers. In some stands *U. europaeus* is replaced by *Cytisus scoparius*. Beneath the gorse and broom there is usually just a sparse and species-poor flora of plants such as *Rubus fruticosus*, *R. idaeus*, *Agrostis capillaris* and *Pteridium aquilinum*. *R. fruticosus* is most common in lowland stands of *Ulex-Rubus* scrub and is absent from many stands in the uplands.

There are three sub-communities. In the *Anthoxanthum odoratum* sub-community W23a, the vegetation beneath the gorse is rather grassy and has several species in common with *Festuca-Agrostis-Galium* grassland U4, including *Anthoxanthum odoratum*, *Agrostis capillaris*, *Holcus lanatus*, *Galium saxatile*, *Potentilla erecta* and the moss *Rhytidiadelphus squarrosus*. The *Rumex acetosella* sub-community W23b shares many species with the *Anthoxanthum* sub-community but has less *Anthoxanthum* and *P. erecta*. It also has a weedier look, with *Rumex acetosella*, *Hypochaeris radicata*, *Senecio jacobaea* and *Plantago lanceolata*. The *Teucrium scorodonia* sub-community W23c is distinguished by *Teucrium scorodonia*, and there can also be a bushy undergrowth of *Hedera helix*. Some forms of *Ulex-Rubus* scrub have little or no vegetation below a dense bushy canopy of *Ulex* or *Cytisus*, and cannot be assigned to any of the sub-communities (Rodwell 1991a). For such a common type of vegetation, *Ulex-Rubus* scrub has been greatly under-sampled in the NVC. Hence it is not surprising that one can find stands that do not fit well into any sub-community: for example, stands with a rank grassy or weedy field layer containing much *Arrhenatherum elatius*, *Dactylis glomerata*, *Urtica dioica* and *Galium aparine*.

#### DIFFERENTIATION FROM OTHER COMMUNITIES

Scattered bushes of *Ulex europaeus* or *Cytisus scoparius* can occur in a wide range of vegetation types (in particular, grasslands, heaths and bracken underscrub) but *Ulex-Rubus* scrub is the only type of British vegetation in which these species are dominant.

#### ECOLOGY

*Ulex-Rubus* scrub occurs on acid, freely-draining soils on gentle to very steep, rocky slopes at low altitudes. Its highest localities are at about 300-350 m on south-facing slopes as far apart as the eastern Highlands and south-west England. The vegetation is mainly secondary, developing after woodland clearance or on abandoned pasture. Progression to woodland may be held in check by re-introduction of stock or by burning. The natural habitats of *Ulex-Rubus* scrub are likely to be steep, rocky slopes on thin soils that cannot support a continuous canopy of tall trees, unstable habitats such as riverside shingle banks, and temporarily disturbed ground after fires in woodland and heath.

#### DISTRIBUTION

*Ulex-Rubus* scrub is common on the fringes of the uplands from south-west England to northern Scotland. It is also widespread in lowland Britain.

Similar vegetation occurs in Ireland and in western mainland Europe.

### ***Pteridium aquilinum-Rubus fruticosus* underscrub (W25)**

#### DESCRIPTION

These are stands of *Pteridium aquilinum* in which the bracken is entangled with *Rubus fruticosus* and in some places *Rosa canina* or *Rubus idaeus*, forming a dense and rather prickly mixture. In south-west England *Hedera helix* is common in this community.

There are two sub-communities: one herb-rich, the other species-poor. The *Hyacinthoides non-scripta* sub-community W25a is the more herb-rich of the two, and is characterised by woodland species, including *Hyacinthoides non-scripta*, *Urtica dioica*, *Heracleum sphondylium*, *Silene dioica*, *Glechoma hederacea* and *Angelica sylvestris*, and tall grasses, such as *Holcus mollis* and *Dactylis glomerata*. The less species-rich *Teucrium scorodonia* sub-community W25b is distinguished by *Teucrium scorodonia* and *Holcus lanatus*, and there can be some *Digitalis purpurea*, *Agrostis capillaris* and *Anthoxanthum odoratum*. Herb-rich stands of bracken in which *Rubus* species are rare or absent but with an understorey including mesotrophic forbs, such as *Filipendula ulmaria*, *Geum rivale*, *Lysimachia nemorum*, *Cirsium heterophyllum* and *Alchemilla glabra*, are quite common on damp soils over basalt, limestone and other base-rich rocks in north Wales, the west Highlands and the Inner Hebrides (e.g. A M Averis 2001b; Averis and Averis 1995a, 1995b, 1999b, 2000a, 2000c). They are related to the *Hyacinthoides* sub-community, but are not currently described in the NVC.

#### DIFFERENTIATION FROM OTHER COMMUNITIES

*Pteridium-Rubus* underscrub is most likely to be confused with the other bracken-dominated NVC type: the *Pteridium-Galium* community U20. The two communities look superficially similar and it is only at close range that the characteristic bramble and other woodland plants of *Pteridium-Rubus* underscrub are visible beneath the fern. The most likely confusion is with the *Anthoxanthum* sub-community of the *Pteridium-Galium* community U20a, which can be moderately herb-rich, but this is grassier, with more *Galium saxatile* and *Potentilla erecta*, less bramble and fewer mesotrophic herbs.

## ECOLOGY

In the uplands, *Pteridium-Rubus* underscrub is a community of the lower hill slopes, occurring below about 300 m on deep, free-draining, fertile soils, many of which are derived from basic parent rocks, such as limestone or basalt. This is well within the zone of woodland, and indeed the flora of the *Hyacinthoides* sub-community can be similar to that of *Fraxinus-Sorbus-Mercurialis* woodland W9. The damp herb-rich form of the community can resemble a bracken-dominated form of the field layer of *Alnus-Fraxinus-Lysimachia* woodland W7.

## DISTRIBUTION

*Pteridium-Rubus* underscrub is widespread in lowland Britain and at low altitudes in upland areas. Within the uplands it is most common in the Inner Hebrides, the western Highlands, the Southern Uplands, the Lake District, Wales and south-west England. It has also been recorded in Jersey, and may occur in mainland western Europe.

### 1.3. Mire communities (M1-12, M15-23, M25-29, M31-33, M37-38)

#### ***Sphagnum denticulatum* bog pool community (M1)**

##### DESCRIPTION

These are shallow peaty pools, wet hollows and soakways in blanket bogs or topogenous mires, filled with a half-submerged, half-floating mass of *Sphagnum denticulatum*. They form colourful and conspicuous red-gold patches over the mire surface. *S. denticulatum* is commonly accompanied by *S. cuspidatum*. Pricking up through the *Sphagnum* is a sparse scatter of plants, including *Narthecium ossifragum* with its bright-yellow, star-shaped flowers, the carnivorous *Drosera* species with their red-fringed, sticky leaves, *Menyanthes trifoliata*, *Juncus bulbosus*, *Eriophorum angustifolium* and, less commonly, *Rhynchospora alba* with its sharp, cream-coloured flowers.

##### DIFFERENTIATION FROM OTHER COMMUNITIES

*Sphagnum cuspidatum/fallax* bog pools M2 resemble this community, but have little or no *Sphagnum denticulatum* and not much *Menyanthes trifoliata*. *Sphagnum denticulatum* bog pools have more *Sphagnum* species, *Carex* species and small aquatic herbs, and less *Eriophorum angustifolium*, than the more species-poor *Eriophorum angustifolium* bog pool M3. *Sphagnum denticulatum* bog pools are unlikely to be confused with other types of vegetation. Stands are usually quite distinct from the surrounding bog communities with their more varied flora of dwarf shrubs and graminoids, such as *Eriophorum vaginatum* and *Molinia caerulea*. In both *Sphagnum*-dominated bog pool communities the peat is much wetter and *Sphagnum* species are usually totally dominant. The boundaries may be rather blurred in shallow and grazed valley mires, but wetter areas with bog pool vegetation are usually recognisable.

##### ECOLOGY

The *Sphagnum denticulatum* community is typical of bog pools in the oceanic west of Britain. The bog vegetation within which it occurs is mostly *Trichophorum-Eriophorum* mire M17 in the north and west, and *Narthecium-Sphagnum* valley mire M21 in the south-west, but it also occurs within stands of *Erica-Sphagnum papillosum* blanket mire M18 and *Calluna-Eriophorum* blanket mire M19, especially in the west Highlands and the Hebrides. Stands are usually on level or very gently-sloping ground, at altitudes below 300 m. The substrate is thick, wet, acid peat with a pH between 3 and 5. In parts of north-western Scotland the community can cover large areas, especially where the bog pools are large, elongated and close together. However, it is more common to find stands covering areas of only a few square metres.

##### DISTRIBUTION

This community occurs throughout the west of Britain between Sutherland and Cornwall, with outliers in the New Forest where it is associated with valley mires. This westerly distribution may to some extent be an artificial pattern, reflecting more thorough mire drainage in the east rather than a dependence on an oceanic climate, but there is insufficient evidence to support either premise (Rodwell 1991b).

There is similar vegetation in the oceanic blanket bogs of western Ireland, where *Rhynchospora alba* and *Erica tetralix* are common (Horsfield *et al.* 1991), and *Schoenus nigricans* may also occur. Similar communities also occur in western Scandinavia.

#### ***Sphagnum cuspidatum/fallax* bog pool community (M2)**

##### DESCRIPTION

Like the *Sphagnum denticulatum* bog pool M1 this is a community of pools, hollows, seepage lines and soakways among bogs, but here the most common species are the soft, feathery, mid-green *Sphagnum cuspidatum* and the neat, grass-green *S. fallax*. The vascular flora consists of a sparse array of dwarf shrubs, including *Erica tetralix*, and small herbs.

There are two sub-communities. The *Rhynchospora alba* sub-community M2a has a moss layer of *Sphagnum cuspidatum* pierced by *Rhynchospora alba*, *Drosera* species, *Narthecium ossifragum* and, in some places, *Andromeda polifolia*. The *Sphagnum fallax* sub-community M2b has as much *S. fallax* as *S. cuspidatum*, if not more, and a healthier vascular flora comprising plants such as *Vaccinium oxycoccos*, *Calluna vulgaris* and *Eriophorum vaginatum*. In north-west England and western Scotland, where the community has not been adequately sampled, the more obvious split within the community is between species-poor stands with little

other than a layer of *Sphagnum cuspidatum* or *S. fallax* or both, and richer stands with an open sward of shrubs and herbs including typical species from both of the two sub-communities.

#### DIFFERENTIATION FROM OTHER COMMUNITIES

This community is very similar to the *Sphagnum denticulatum* bog pool but *S. fallax* is much more common, and *S. denticulatum* is usually absent. Occurrences of *Andromeda polifolia* in bog pools are mostly in the *Sphagnum cuspidatum/fallax* community. The differentiation of *Sphagnum*-dominated bog pools from associated types of mire is usually straightforward (see comments on p xx).

#### ECOLOGY

This community forms pools on the surface of wet, base-poor blanket mires or raised mires. In the lowlands it is mostly associated with raised mires but in the uplands it can occur in *Erica-Sphagnum papillosum* mire M18, *Trichophorum-Eriophorum* mire M17 or *Calluna-Eriophorum* mire M19. The pools are usually sharply demarcated from the surrounding mire surface. *Sphagnum cuspidatum/fallax* pools also occur within *Narthecium-Sphagnum* valley bogs M21 in south-west England, and here they tend to merge into the surrounding mire vegetation. Although most stands are at low altitudes *Sphagnum cuspidatum/fallax* vegetation can occur in blanket mires above 500 m.

#### DISTRIBUTION

Bog pools of this type are widespread throughout blanket and valley mires in the uplands, from Cornwall north to the Highlands. It is not as western in its distribution as the *Sphagnum denticulatum* bog pool; it occurs further east in parts of the country where the climate is drier and where winters are cold.

There is similar vegetation in Ireland, and in mainland Europe from Scandinavia to northern France.

### ***Eriophorum angustifolium* bog pool community (M3)**

#### DESCRIPTION

Most stands of this community consist of dark-red-green, species-poor swards of *Eriophorum angustifolium* growing on wet, redistributed peat in disturbed areas of blanket bog. *E. angustifolium* can grow in dense swards here, but equally commonly it occurs as sparse shoots scattered over the dark expanses of peat. Beneath the cotton grass there is rarely a continuous layer of plants; it is more usual to see spreads of bare peat with scattered plants of *Carex echinata*, *Molinia caerulea*, *Calluna vulgaris*, and the mosses *Polytrichum commune*, *Sphagnum papillosum*, *S. fallax* and *Campylopus flexuosus*. Less commonly, there is a more extensive layer of Sphagna and *P. commune*. In some places there are also a few plants of *Menyanthes trifoliata*, *Narthecium ossifragum*, *Erica tetralix*, and the bog liverworts *Odontoschisma sphagni* and *Gymnocolea inflata*.

#### DIFFERENTIATION FROM OTHER COMMUNITIES

This community is hard to confuse with any other vegetation type. *Eriophorum angustifolium* can be very common in blanket mire, but in *Eriophorum angustifolium* bog pools it is strongly dominant, the flora is very impoverished, and there are rarely any dwarf shrubs. There is more *E. angustifolium* and less *Sphagnum* in most stands of *Eriophorum angustifolium* vegetation than in the *Sphagnum denticulatum* and *Sphagnum cuspidatum/fallax* bog pool communities. *E. angustifolium* can be very common in some stands of *Carex-Potentilla* tall-herb fen S27, but that vegetation is much more herb-rich.

#### ECOLOGY

*Eriophorum angustifolium* bog pools occur typically on wet, exposed, acid peat in blanket bogs, where *E. angustifolium* is usually one of the first colonising species. The community can persist where the water-level fluctuates, as well as occurring in permanently flooded pools or dried-up hollows. Although it can occur in situations such as flushed channels, it is generally most extensive where the original bog vegetation has been lost, for example on peat cuttings or where there has been damage by vehicles or by trampling animals. The community can cover substantial areas of flat, exposed peat between hags in eroding bogs. It can also occur in natural hollows where other forms of bog pool vegetation may have been impoverished by burning. It is possible that vegetation resembling the original mire communities may re-establish once the peat has been stabilised by the *Eriophorum*, but this has not been studied (Rodwell 1991b). The matrix of bog vegetation within which *Eriophorum angustifolium* bog pools occur is usually *Calluna-Eriophorum* mire M19 or *Eriophorum vaginatum* mire M20, but may also be *Trichophorum-Eriophorum* mire M17 or *Trichophorum-Erica* wet heath M15. As a component of montane blanket mire *Eriophorum angustifolium* bog pools reach altitudes of over 900 m.

## DISTRIBUTION

The distribution of the community follows that of blanket bogs and wet heaths. It is widespread in the north and west, especially among eroding *Calluna-Eriophorum* mires.

The community also occurs on eroding blanket bog in Ireland (Hobbs and Averis 1991b), and there is similar vegetation elsewhere in northern and western Europe.

### ***Carex rostrata-Sphagnum fallax* mire (M4)**

## DESCRIPTION

This is a tall, even, grey-green sward, with the leaves of *Carex rostrata* swaying in the slightest breeze over a closely-packed, bright-green, spongy carpet of *Sphagnum palustre*, *S. fallax*, *S. denticulatum*, *S. papillosum* and *Polytrichum commune*. There is little else to enrich the sward except for the odd plant of species such as *Potentilla erecta*, *Viola riviniana*, *Agrostis canina* and *Carex nigra*.

## DIFFERENTIATION FROM OTHER COMMUNITIES

This community represents the oligotrophic end of a series of *Carex rostrata* mires. Two other types of *Carex rostrata* mire have a moss layer consisting of Sphagna: *Carex-Sphagnum squarrosum* mire M5 and *Carex-Sphagnum warnstorffii* mire M8. These two communities are neither as acid nor as species-poor as *Carex rostrata-Sphagnum fallax* mire. Their *Sphagnum* carpet is made up of mildly base-tolerant species, such as *S. squarrosum*, *S. warnstorffii*, *S. teres* and *S. contortum*, and they are dotted with *Potentilla palustris* and *Aulacomnium palustre*, as well as more obviously mesotrophic plants, including *Parnassia palustris*, *Lychnis flos-cuculi*, *Filipendula ulmaria*, *Selaginella selaginoides*, *Thalictrum alpinum* and *Carex pulicaris*. The moss layer of *Carex rostrata-Sphagnum fallax* mire is similar to that of *Carex echinata-Sphagnum* mire M6, which is split into four sub-communities according to the dominant sedges or rushes. Perhaps the vegetation currently described as *Carex rostrata-Sphagnum fallax* mire could equally well be classed as a *Carex rostrata* sub-community of *Carex echinata-Sphagnum* mire.

## ECOLOGY

*Carex rostrata-Sphagnum fallax* mires occur on wet peat where there is some lateral water movement or in hollows with stagnant water. Stands are typically hidden among bogs and grassland in shallow depressions where water drains diffusely through poor acid soils. They are also common around lochs where water seeps slowly down slopes. Where they occur in mosaics with other mire communities they commonly occupy the wettest ground close to the source of irrigation. The peats are acid with a surface pH of around 4.0. Most examples are at moderate altitudes, but the community can occur above 600 m.

## DISTRIBUTION

*Carex rostrata-Sphagnum fallax* mires are distributed throughout the British uplands from south-west England to northern Scotland. Although most stands are small, large spreads can occur where conditions are suitable, for example in shallow, ill-drained basins among blanket bog and soligenous mires on the upland plateaux of mid and north Wales.

Related vegetation occurs widely in Scandinavia and elsewhere in western Europe.

### ***Carex rostrata-Sphagnum squarrosum* mire (M5)**

## DESCRIPTION

This is a wet mire with an extensive or patchy layer of the mesotrophic or base-tolerant *Sphagnum* species *S. squarrosum*, *S. fallax* and *S. teres* below a thin, grey-green canopy of sedges. The mats of Sphagna are variegated with the yellow-green shoots of *Aulacomnium palustre*, the translucent, ochre-green leaves of *Rhizomnium punctatum*, and the golden, branched shoots of *Calliergonella cuspidata* and *Campylium stellatum*. *Carex rostrata* is usually the most common sedge, but *C. nigra*, *C. curta* and *C. echinata* may also occur. There is typically a rich array of tall forbs, such as *Mentha aquatica*, *Lychnis flos-cuculi*, *Myosotis scorpioides*, *Galium palustre*, *Potentilla palustris* and *Filipendula ulmaria*, as well as *Menyanthes trifoliata*, *Equisetum fluviatile*, *Hydrocotyle vulgaris* and *Potamogeton polygonifolius*. These mires can be attractive in summer when the forbs are in flower and the bright colours stand out from the muted greens and browns of the surrounding vegetation.

## DIFFERENTIATION FROM OTHER COMMUNITIES

*Carex-Sphagnum squarrosum* mire superficially resembles the other mire communities dominated by *Carex rostrata*. The best distinguishing species are the mosses *Sphagnum squarrosum* and *S. teres*. In *Carex rostrata-Sphagnum fallax* mire M4, the moss layer consists mainly of *S. fallax*, *S. palustre* and *Polytrichum commune*. *Carex-Sphagnum warnstorffii* mire M8 has less *S. squarrosum*, *Potentilla palustris*, *Eriophorum angustifolium* and *Succisa pratensis*, and more *S. warnstorffii* than *Carex rostrata-Sphagnum squarrosum* mire. In *Carex-Calliergonella* mire M9 Sphagna are rare, and the most common bryophytes are *Calliergonella cuspidata*, *Calliergon* species and other mesotrophic mosses. Vegetation similar to *Carex-Sphagnum squarrosum* mire but with little or no *C. rostrata* is included among the small-sedge mires described on p xxx.

#### ECOLOGY

This is a community of loch-sides, pools and fens where there is mild base enrichment, either from the underlying rock or from irrigating water. It occurs where the pH is a little higher than in the *Carex rostrata-Sphagnum fallax* mire, but where conditions are not as base-rich as they are in the *Carex-Calliergonella* mire. The substrate is a soft, wet peat that protects the community from fire and grazing animals. *Carex-Sphagnum squarrosum* mire usually occurs in mosaics with other mire communities, where local variations in wetness and nutrient status are reflected in complex patterns of vegetation. It can occur from a few tens of metres above sea-level to almost 900 m, well into the montane zone.

#### DISTRIBUTION

This community is widespread but scarce in both upland and lowland parts of northern and western Britain.

Related vegetation types occur locally in Scandinavia and parts of central Europe.

### ***Carex echinata-Sphagnum fallax/denticulatum* mire (M6)**

#### DESCRIPTION

These are soligenous mires with a sward of sedges or rushes over a dense, green and gold layer of the mosses *Sphagnum fallax*, *S. denticulatum*, *S. palustre* and *Polytrichum commune*; *S. papillosum* and *Rhytidiadelphus squarrosus* can be common here too. The sward is usually interleaved with *Agrostis canina* and *Molinia caerulea*. The only common forbs are *Viola palustris* and *Potentilla erecta*, though there may also be a little *Galium saxatile* or *Cirsium palustre*.

There are four sub-communities, defined by the sedge or rush species that predominate in the sward. The *Carex echinata* sub-community M6a is a dull-green assemblage of *Carex echinata* together with other sedges (mainly *C. panicea* and *C. nigra*), in some places with a few fen plants, such as *Potentilla palustris* and *Menyanthes trifoliata*, and the sundew *Drosera rotundifolia*. The *Carex nigra-Nardus stricta* sub-community M6b is described in the NVC as a mixed, paler sward of *C. nigra*, *C. panicea*, *Eriophorum angustifolium*, *Juncus squarrosus* and *Nardus stricta*. *Festuca ovina* and *Anthoxanthum odoratum* are common here and the vegetation can resemble flushed grassland. There is also another type of vegetation - usually a topogenous mire - which is distinctive but appears to fit within this sub-community. This is an even sward of pure or nearly pure *C. nigra* growing through an extensive carpet of Sphagna and *Polytrichum commune*. The other two sub-communities are dominated by rushes: the *Juncus effusus* sub-community M6c and the *Juncus acutiflorus* sub-community M6d are characterised by tall, deep-green swards of one or other species. Although these are all acid, species-poor mires, the *Juncus acutiflorus* sub-community can include *Myosotis secunda*, *Ranunculus acris* and other forbs that are scarce in the other sub-communities.

#### DIFFERENTIATION FROM OTHER COMMUNITIES

The *Carex echinata* and *Carex-Nardus* sub-communities of *Carex echinata-Sphagnum* mire can be distinguished from other sub-montane small-sedge mires because they have a carpet of Sphagna rather than more mesotrophic mosses. They are also relatively species-poor, without the array of small forbs characteristic of the richer mires. The montane counterpart of these acid flushes is *Carex-Sphagnum russowii* mire M7. This can look very similar to *Carex echinata-Sphagnum* mire but has less *Molinia* and *Sphagnum palustre*, and usually contains some montane species, such as *Carex bigelowii*, *Sphagnum russowii* or *Saxifraga stellaris*. *Carex rostrata-Sphagnum fallax* mire M4 has a moss layer similar to that in *Carex echinata-Sphagnum* mire, but the graminoid sward there is of *C. rostrata* rather than rushes or short sedges.

The *Juncus effusus* and *Juncus acutiflorus* sub-communities of *Carex echinata-Sphagnum* mire can only be confused with *Juncus-Galium* rush-pasture M23, which has a richer flora of herbs, and mosses such as *Calliergonella cuspidata*, *Brachythecium rutabulum* and *B. rivulare* rather than Sphagna and *Polytrichum commune*.

## ECOLOGY

These mires occur in wet hollows, seepage lines, flushes, shallow gullies cutting down hillsides, and along the margins of streams within expanses of blanket mire, dwarf-shrub heath or acid grassland. They also occur around slow-flowing springs at the heads of rivers. For example, the River Tweed in the Scottish borders rises in a large, wet, spongy hollow filled with this type of mire vegetation. Similarly in Wales, the Wye and the Severn rise among these mires on the shallow dome of Pumlumon. *Carex echinata-Sphagnum* mires also cover level, ill-drained valley floors, and are common in neglected and abandoned pastures on the upland margins.

The soils beneath *Carex echinata-Sphagnum* flushes are deep, wet and usually peaty. The irrigating water is acid with a pH between 4.4 and 5.7 (McVean and Ratcliffe 1962). The supply of plant nutrients is greater than it is in the stagnant *Sphagnum denticulatum* M1, *Sphagnum cuspidatum/fallax* M2 and *Eriophorum angustifolium* M3 bog pool communities, but less than it is in the base-rich small-sedge mires *Carex-Pinguicula* M10, *Carex-Saxifraga* M11 and *Carex saxatilis* M12. *Carex echinata-Sphagnum* mire is mainly a community of the sub-montane zone up to about 400 m, although in northern England, in Wales and on Dartmoor, there are stands of the *Juncus effusus* sub-community above 550 m along the sheltered gullies of winding, sluggish streams.

## DISTRIBUTION

*Carex echinata-Sphagnum* mires are common throughout the uplands from Cornwall north to Shetland. They are the most widespread soligenous mires in the British uplands. The two sedge-dominated sub-communities are ubiquitous. The two rush-dominated sub-communities are widespread in Wales, northern England and southern Scotland but are less common in the northern Highlands and the Outer Hebrides. For example, the *Juncus acutiflorus* sub-community is very common in the south-west Highlands but is scarce further north. *Carex echinata-Sphagnum* mire has also been recorded in the lowlands, for example on Anglesey and in a few places in Cheshire, Dorset and south-eastern England.

There is similar vegetation in western Europe, including Iceland, but the *Juncus acutiflorus* and *Juncus effusus* sub-communities are almost confined to Britain and Ireland (White and Doyle 1982).

## ***Carex curta-Sphagnum russowii* mire (M7)**

### DESCRIPTION

These small mires lie half-hidden in flushed hollows, surrounded by bogs or montane grasslands. The short, grey-green sward of *Carex echinata*, *C. curta*, *C. nigra*, and *Eriophorum angustifolium* has a dense, ochre-green underlay of *Sphagnum papillosum* and, in many stands, *S. russowii*. The associated flora is generally rather species-poor. There can be a few grasses, such as *Nardus stricta* and *Agrostis canina*, and in most stands the pale-green, rounded leaves of *Viola palustris* are dotted over the carpet of Sphagna.

There are two sub-communities. The *Carex bigelowii-Sphagnum lindbergii* sub-community M7a has much *Carex bigelowii* and *Nardus*; *C. curta* can be absent. *Sphagnum subnitens* and *S. denticulatum* predominate in the moss layer. There is more *C. curta* in the *Carex aquatilis-Sphagnum fallax* sub-community M7b, and here the place of *C. bigelowii* is taken by *C. aquatilis*, and that of *S. lindbergii*, *S. subnitens* and *S. denticulatum* by *S. fallax*, *Calliergon stramineum* and *Polytrichum commune*.

### DIFFERENTIATION FROM OTHER COMMUNITIES

Montane species, such as *Festuca vivipara*, *Saxifraga stellaris*, *Carex bigelowii*, *Sphagnum russowii* and *S. lindbergii*, are quite common in *Carex-Sphagnum russowii* mire but are generally absent from stands of the related *Carex echinata-Sphagnum* mire M6. *Carex-Sphagnum russowii* mire also has more *C. curta*, whereas some of the common species of *Carex echinata-Sphagnum* flushes, such as *Sphagnum palustre*, *Juncus effusus* and *Molinia caerulea*, are scarce. *Carex-Pinguicula* mire M10, which also occurs in the montane zone, is distinguished by its calcicolous flora; it also usually has a sparser sward than *Carex-Sphagnum russowii* mire. *Carex saxatilis* mire M12, another montane flush community, bears a superficial resemblance to *Carex-Sphagnum russowii* mire but is dominated by *C. saxatilis* and usually contains at least a few other calcicolous forbs or mosses.

## ECOLOGY

*Carex-Sphagnum russowii* mires are the montane counterpart of the sedge-dominated forms of *Carex echinata-Sphagnum* mire. They occur above 600 m, occupying flushed hollows over wet peats on high slopes,

in corries and on plateaux. They are commonly set in a matrix of montane blanket mire, but also occur around springs and snow-beds, and around lochans and shallow pools. The community is apparently indifferent to geology, as it is insulated by the peat from the underlying rocks, but the irrigating water is generally acid. Most stands are covered by deep snow in the winter (McVean and Ratcliffe 1962), so the plants that grow there must tolerate a short growing-season and irrigation with icy water.

#### DISTRIBUTION

Most stands of *Carex-Sphagnum russowii* mire occur in the east-central and north-western Highlands where snow lies late on the high ground. The community also occurs in the Breadalbane range, extending south-west into the Cowal hills. There are similar mires in the Lake District, although they have fewer montane species. Some of the best and largest stands of the community are in the Cairngorm, Monadhliath and Caenlochan hills and on Lochnagar, but there are also good examples further west on Ben Alder, the Affric-Cannich hills, Beinn Dearg at the head of Loch Broom, and Ben More Assynt.

There is similar vegetation in Scandinavia. This community is an important link between montane vegetation in Britain and that in more continental parts of Europe.

### ***Carex rostrata-Sphagnum warnstorffii* mire (M8)**

#### DESCRIPTION

This mire consists of a grey-green sward of *Carex rostrata*. Beneath the sedge there is a red-tinged carpet of *Sphagnum warnstorffii*, variegated with green-brown tufts of *S. teres*, golden-green, pointed shoots of *Calliergonella cuspidata*, golden, finely-branched stems of *Hylocomium splendens*, and thick, yellow-green mats of *Aulacomnium palustre*. Small vascular plants, such as *Thalictrum alpinum*, *Carex pulicaris* and *Selaginella selaginoides*, grow through the moss carpet.

#### DIFFERENTIATION FROM OTHER COMMUNITIES

This community is distinguished from the more lowland *Carex-Sphagnum squarrosum* mire M5 by the presence of montane species, such as *Thalictrum alpinum* and *Persicaria vivipara*; other differences between the two communities are outlined on p xx. *Carex-Sphagnum warnstorffii* mire is intermediate in its nutrient levels and flora between the oligotrophic *Carex rostrata-Sphagnum fallax* mire M4 and the mesotrophic *Carex-Calliergonella* mire M9. In comparison with *Carex-Calliergonella* mire, *Carex-Sphagnum warnstorffii* mire has much more *Sphagnum* and fewer calcicolous brown mosses, such as *Drepanocladus revolvens* and *Scorpidium scorpioides*. *Sphagnum warnstorffii*, *Selaginella selaginoides*, *Carex pulicaris* and other species characteristic of mildly base-rich conditions distinguish *Carex-Sphagnum warnstorffii* mire from *Carex rostrata-Sphagnum fallax* mire.

#### ECOLOGY

*Carex-Sphagnum warnstorffii* mire is confined to wet hollows with stagnant, moderately base-rich water at moderate to high altitudes. Most stands are above 400 m. Underlying the vegetation there is usually peat more than one metre deep and with a pH between 5.5 and 5.7 (McVean and Ratcliffe 1962). In many places this type of mire is sharply demarcated from the surrounding vegetation, which is usually some form of montane grassland.

#### DISTRIBUTION

*Carex-Sphagnum warnstorffii* mire is rare in Britain, evidently because waterlogged hollows with base-rich water are scarce in wet upland regions where leaching usually leads to more acidic, oligotrophic soils. The community is most common on the Dalradian schist of the Breadalbane hills in central Scotland, where there are particularly good examples on Ben Lawers and Ben Vrackie. There are outliers in Sutherland, Lochaber, on base-rich Silurian rocks in the Southern Uplands, on limestone in the north Pennines, and on volcanic rocks in the Lake District and north Wales.

Similar vegetation occurs in Scandinavia where it is more common and more species-rich than it is in Scotland. Scandinavian stands usually have more montane species, particularly willows.

### ***Carex rostrata-Calliergonella cuspidata/Calliergon giganteum* mire (M9)**

#### DESCRIPTION

Like *Carex rostrata-Sphagnum fallax* M4, *Carex-Sphagnum squarrosum* M5 and *Carex-Sphagnum warnstorffii* M8 mires, this is a grey-green sward of *Carex rostrata* and *Eriophorum angustifolium* interleaved with

*Menyanthes trifoliata*, *Potentilla palustris* and *Galium palustre*. These plants grow through a deep, wet mass of mosses comprised of *Calliergonella cuspidata*, *Campyllum stellatum*, *Scorpidium scorpioides* and other species, rather than the Sphagna that are characteristic of the other three communities.

There are two sub-communities. The *Campyllum stellatum-Scorpidium scorpioides* sub-community M9a has a more open sward, in which *Carex limosa* and *C. echinata* are common, and mosses, including *Campyllum stellatum*, *Drepanocladus revolvens* and *Scorpidium scorpioides*, grow in glossy wefts over the wet ground. The *Carex diandra-Calliergon giganteum* sub-community M9b has a taller, denser sward in which *C. diandra* and mesotrophic forbs, such as *Caltha palustris*, *Mentha aquatica*, *Angelica sylvestris*, *Lychnis flos-cuculi* and *Filipendula ulmaria*, are common.

#### DIFFERENTIATION FROM OTHER COMMUNITIES

The superficially similar *Carex-Sphagnum warnstorffii* and *Carex-Sphagnum squarrosum* mires have Sphagna instead of the *Calliergonella cuspidata* and other mosses characteristic of *Carex-Calliergonella* mire. Some of the base-tolerant Sphagna, including *S. contortum* and *S. warnstorffii*, occur locally in *Carex-Calliergonella* mire but they are not common in this community.

In the uplands, *Carex-Calliergonella* mire is unlikely to be confused with related lowland swamps and fens, but in more marginal hill ground, such as on the basalt of Mull and Skye, the *Carex-Calliergon* sub-community can be hard to separate from the *Lysimachia* sub-community of *Carex-Potentilla* tall-herb fen S27b. *Carex rostrata*, *Eriophorum angustifolium*, *Menyanthes trifoliata*, *Potentilla palustris* and *Galium palustre* are among the many species that are common to both forms of vegetation. *Carex-Potentilla* fen generally includes tall forbs, such as *Lysimachia vulgaris*, *Phragmites australis*, *Lythrum salicaria* and *Iris pseudacorus*, that are rare in *Carex-Calliergonella* mire. *Carex-Calliergonella* mire generally has a more or less continuous layer of mosses below the vascular plants, whereas in *Carex-Potentilla* fen the vascular plants usually form dense mats standing in or floating on shallow water with a patchier underlayer of mosses. However, many stands of vegetation cannot be assigned clearly to either community.

Some examples of *Carex-Calliergonella* mire resemble *Carex-Pinguicula* mire M10 except that they have a sedge sward consisting mainly of *C. rostrata*, rather than smaller species, such as *C. viridula* ssp. *oedocarpa*, *C. panicea* and *C. dioica*.

#### ECOLOGY

This community is confined to places where base-rich water seeps through deep, wet peat. It occurs in hollows and seepage lines in blanket bogs, in calcareous fens, in topogenous mires, and around lochans, springs and raised mires. A characteristic setting is where base-rich water from calcareous springs runs over blanket peat (McVean and Ratcliffe 1962). Most upland stands are on limestone, calcareous schist or glacial drift. The water-level can fluctuate dramatically, but is rarely so low that the vegetation dries out altogether. Stands of *Carex-Calliergonella* mire are usually small and typically occur in mosaics with other mires where the distribution of the various communities is determined by local variations in base-status. The community has been recorded up to almost 800 m (McVean and Ratcliffe 1962). It also occurs in the lowlands of south-east England in fens and basin mires (Rodwell 1991b).

#### DISTRIBUTION

*Carex-Calliergonella* mire is widespread but scarce in the British uplands, where most stands belong to the *Campyllum-Scorpidium* sub-community. In upland regions the community is perhaps most common on the calcareous Dalradian rocks of the Breadalbane region, on the limestone and basalt of Skye and Lismore, and on the basalt of Mull. It also occurs in the lowlands, for example in the fens of East Anglia and north-west Wales.

Similar vegetation occurs in topogenous mires in Norway and Sweden, although British examples generally have more oceanic species (McVean and Ratcliffe 1962).

### ***Carex dioica-Pinguicula vulgaris* mire (M10)**

#### DESCRIPTION

These mires have a patchy sward of sedges and bryophytes, studded with the lime-green, sticky stars of *Pinguicula vulgaris*. The most common sedges are the bright-green *Carex viridula* ssp. *oedocarpa*, the grey-green *C. panicea* and the dark-green, fine-leaved *C. dioica*. Below the sparse canopy of sedges there are tufts and wefts of calcicolous mosses, including *Drepanocladus cossonii*, *D. revolvens*, *Scorpidium*

*scorpioides*, *Campylium stellatum* and *Blindia acuta*. Many stands have little more than this, but the most species-rich examples have a rich array of small calcicoles, such as *Thalictrum alpinum*, *Tofieldia pusilla*, *Selaginella selaginoides*, *Eleocharis quinqueflora* and *Saxifraga oppositifolia*. There can be some tufa formation. As with other base-rich mires there can be a strong smell of decomposing vegetation.

There are three sub-communities. The *Carex viridula* ssp. *oedocarpa*-*Juncus bulbosus* sub-community M10a is the most widespread and occurs on slightly more acid soils. In addition to *C. viridula* ssp. *oedocarpa* and *Juncus bulbosus*, it is defined by species such as *Erica tetralix*, *Eleocharis quinqueflora*, *Narthecium ossifragum* and *Drosera rotundifolia*; *Schoenus nigricans* can also be common here. The *Briza media*-*Primula farinosa* sub-community M10b is distinguished by more basiphilous species, including *Briza media*, *Primula farinosa*, *Linum catharticum* and *Carex flacca*. The *Hymenostylium recurvirostrum* sub-community M10c is an unusual assemblage of species including *Plantago maritima*, *Sagina nodosa* and *Minuartia verna*, as well as the montane *Carex capillaris* and *Juncus triglumis*, and the moss *Hymenostylium recurvirostrum*.

#### DIFFERENTIATION FROM OTHER COMMUNITIES

Most calcicolous small-sedge mires in the uplands belong to either this community or *Carex-Saxifraga* mire M11. These two communities have many species in common and can be difficult to distinguish. The NVC tables suggest that the moss *Blindia acuta* is more characteristic of *Carex-Saxifraga* mire, but this species is actually also common in many stands of *Carex-Pinguicula* mire. The most reliable distinguishing species is *Saxifraga aizoides*, which is generally scarce in *Carex-Pinguicula* mire. There are usually more montane species in *Carex-Saxifraga* mire. Both mires can form very open and stony flushes; those on a more continuous layer of soil are mostly *Carex-Pinguicula* mire.

#### ECOLOGY

The community can occur wherever there is flushing with base-rich water, either below a springhead or where water emerges more diffusely from the ground. Most stands are constantly irrigated. They appear as elongated or oval patches, often in vertical strips running downslope from lines of springs. On flatter ground they can spread out in anastomosing channels covering a large area. The soils are saturated, silty muds with a surface of humus or shallow peat, and with a pH between 5.9 and 6.3 (McVean and Ratcliffe 1962). Stands can occur from sea-level (in the north-west) to over 900 m, especially in central Scotland where there is calcareous rock at high elevations. Most stands are set in a matrix of upland grassland or heath, but the community also occurs in upland woods.

#### DISTRIBUTION

*Carex-Pinguicula* mires occur throughout the uplands of Scotland, northern England and Wales, wherever there are base-rich substrates and associated flushes. They are particularly common on the basic Dalradian rocks in the Breadalbane region of the Highlands. They are not recorded from south-west England. The *Carex-Juncus* sub-community is the most common form; the *Briza-Primula* sub-community occurs mainly in northern England and southern Scotland; the *Hymenostylium* sub-community has been recorded only from limestone hills in the Pennines.

There is vegetation similar to *Carex-Pinguicula* mire in mainland Europe, although the Scandinavian counterparts tend to be ungrazed and to contain montane *Salix* species. Essentially the same type of vegetation also occurs in the Faroe Islands (Hobbs and Averis 1991a).

### ***Carex viridula* ssp. *oedocarpa*-*Saxifraga aizoides* mire (M11)**

#### DESCRIPTION

These are stony flushes of base-rich hillsides at high altitudes. The grass-green *Carex viridula* ssp. *oedocarpa* and the grey-green *C. panicea* and *C. pulicaris* form a sparse sward mixed with the succulent-leaved *Saxifraga aizoides* which has conspicuous starry yellow flowers in summer. Between the vascular plants there are tufts and patches of calcicolous bryophytes growing on wet stones and bare, muddy soil; *Blindia acuta*, *Drepanocladus cossonii*, *D. revolvens*, *Campylium stellatum*, *Preissia quadrata*, *Calliergon trifarium* and *Fissidens adianthoides* are among the most characteristic species.

There are two sub-communities, dividing the more montane from the less montane stands. The *Thalictrum alpinum*-*Juncus triglumis* sub-community M11a is home to many montane species, of which the most common are *Juncus triglumis*, *Thalictrum alpinum* and *Persicaria vivipara*. In the *Palustriella commutata*-*Eleocharis quinqueflora* sub-community M11b there are fewer montane plants, and more *Eleocharis quinqueflora*, *Schoenus nigricans*, *Carex hostiana* and *Palustriella commutata*.

## DIFFERENTIATION FROM OTHER COMMUNITIES

*Carex-Saxifraga* mire is very similar to *Carex-Pinguicula* mire M10 but *Saxifraga aizoides* and other montane species are usually more common. However, the separation of the two communities can be hard to justify on some hills where they would be better described as a single well-defined type of vegetation. *Carex-Saxifraga* mire also has close affinities with *Carex saxatilis* mire M12, but this community is typically dominated by *Carex saxatilis* and has less *S. aizoides* and *Carex pulicaris*. The more lowland *Palustriella-Eleocharis* sub-community can resemble *Palustriella-Carex* spring vegetation M37, and indeed the two can occur together, but it has more *Carex viridula* ssp. *oedocarpa*, *C. panicea*, *Blindia acuta*, *Drepanocladus revolvens*, *Campylium stellatum* and *Eleocharis quinqueflora*. Prominence of *Carex* and *Juncus* species are more common in *Carex-Saxifraga* mire than in *Saxifraga-Alchemilla* vegetation U15.

## ECOLOGY

*Carex-Saxifraga* mire is a spring-fed community of slopes or channels where the water usually flows rapidly over the surface. Some rocks provide more favourable substrates than others, and the soft, easily-weathered mica-schist of the Breadalbanes is particularly good, forming sheets of unstable, base-rich debris. Although the community can occur close to sea-level in the far north-west, most stands are at altitudes above 500 m and many of the constituent species are montane plants. Stands are usually small but can form mosaics with other communities over a large area.

## DISTRIBUTION

*Carex-Saxifraga* mire occurs from north Wales to Shetland, but is most widespread and best developed in the Scottish Highlands. Some of the largest stands are on the calcareous Dalradian rocks of the Breadalbanes, but there are also fine examples on the limestone and basalt hills of the north-west Highlands and on the Borrowdale Volcanic rocks of the Lake District. Welsh stands have fewer montane species and lack *Saxifraga aizoides*.

There is similar vegetation elsewhere in the mountains of northern and central Europe.

## ***Carex saxatilis* mire (M12)**

## DESCRIPTION

This mire community consists of dark-green swards of *Carex saxatilis* in which the stiff, curved leaves of the sedge give a distinct texture to the vegetation. The flushes are set into small hollows or gullies on high hillsides or spread over irrigated slopes, and are studded in summer with the black flowers of *C. saxatilis*. Other characteristic species include *Deschampsia cespitosa* and *C. viridula* ssp. *oedocarpa*. Hidden among the stems of the sedges is a rich array of small vascular plants, including scarce montane calcicoles such as *Persicaria vivipara*, *Saxifraga aizoides*, *S. oppositifolia*, *Thalictrum alpinum* and *Juncus triglumis*. At the base of the sward is a loose layer of *Campylium stellatum*, *Fissidens adianthoides*, *Ctenidium molluscum*, *Scorpidium scorpioides* and other calcicolous mosses.

## DIFFERENTIATION FROM OTHER COMMUNITIES

This community can be confused only with *Carex-Saxifraga* mire M11 and *Carex-Pinguicula* mire M10. Various differences between the three communities are apparent from the NVC tables, but they have so many species in common that the abundance of *Carex saxatilis* provides the most reliable means of distinguishing *Carex saxatilis* mire.

## ECOLOGY

This is a montane community of high slopes above 700 m in corries where snow lies late and which are flushed with cold, base-rich water. It is most common downslope of north-facing cliffs, where there is some snow-lie in winter and where there is constant irrigation from dripping rocks above. The underlying soils are generally base-rich, humus-rich muds or peats with a pH between 4.6 and 5.7 (McVean and Ratcliffe 1962). Prolonged snow cover, strong flushing from melting snow, freeze-thaw and solifluction keep the soils unstable and maintain an open, stony habitat. This enables the rarer small sedges and forbs to find a niche and discourages colonisation by larger competitors.

## DISTRIBUTION

*Carex saxatilis* mire is confined to the Scottish Highlands, between Ben More Assynt in the north, Ben Lui and Beinn Ime in the south-west, and Caenlochan in the east. It occurs only where there are base-rich rocks and

so is most common on the Dalradian mica-schist of the Breadalbanes. In the north-west it occurs on base-rich outcrops of Moine or Lewisian rocks (McVean and Ratcliffe 1962).

There is similar vegetation in the Faroe Islands (Hobbs and Averis 1991a), Norway and Sweden.

### ***Trichophorum cespitosum-Erica tetralix wet heath (M15)***

#### DESCRIPTION

Most of the ubiquitous wet heaths in the north and west of Scotland belong to this type of vegetation. These vast, ochre-brown tracts of moorland consist of mixtures of *Calluna vulgaris*, *Erica tetralix*, *Trichophorum cespitosum* and *Molinia caerulea*, entwined with *Potentilla erecta*, and pricked through by the narrow, upright shoots of *Narthecium ossifragum* and the long, dark-green leaves of *Eriophorum angustifolium*.

There are four sub-communities, representing points fairly widely spaced along the continuum of variation within the community. *Trichophorum-Erica* wet heath is more variable than the NVC tables indicate. It seems to have been inadequately sampled, perhaps because it is so common and because it does not attract much attention from botanists in search of rare species.

The *Carex panicea* sub-community M15a is more of a soligenous mire than a wet heath, with a thin canopy of the characteristic species augmented by *Carex panicea* and other vascular plants, such as *C. echinata*, *Juncus squarrosus* and *Drosera rotundifolia*. There is a patchy carpet of mosses over the wet peaty ground in which the most common species are usually *Sphagnum denticulatum* and *Campylopus atrovirens*. There can be small patches of other bryophytes, such as the mosses *Breutelia chrysocoma*, *Racomitrium lanuginosum*, *S. capillifolium* and *S. papillosum*, and the liverwort *Pleurozia purpurea*. In the west Highlands and the Hebrides *Schoenus nigricans* can grow in thick, whitish tussocks in this type of mire, and on Skye and the Outer Hebrides some stands have bright-green sheets of the rare moss *Campylopus shawii*. Flushes with much *Campylopus atrovirens* and a sparse sward of *Narthecium*, *Trichophorum*, *C. panicea* and *Nardus stricta* also belong to the *Carex* sub-community. They are more common at higher altitudes and occur in depressions in grasslands as well as in wet heaths and bogs. These correspond to the *Narthecium-Sphagnum* flush of Birks and Ratcliffe (1980).

The Typical sub-community M15b has a thick tufted sward of *Calluna*, *E. tetralix*, *Molinia* and *Trichophorum*, and there can be a thick speckling of *Myrica gale* with its sweet, spice-scented leaves. Under the canopy the ground may be clad with a pale fawn layer of *Molinia* litter. There are commonly small patches of *Sphagnum capillifolium*, *S. denticulatum*, *S. papillosum* and *Campylopus atrovirens*, and *Pleurozia purpurea* may also be common. *Schoenus nigricans* occurs locally in this type of vegetation in the far north-west. Some stands are dense, tall, species-poor swards, comprising little more than *Calluna* and *Molinia*.

The *Cladonia* species sub-community M15c has a shorter and more open sward. *Myrica* is rare here, and *Erica cinerea* can be as common as *E. tetralix*. Despite the name of the sub-community, not all stands have a rich flora of lichens. More characteristic in western stands is the moss *Racomitrium lanuginosum*, which grows in a thin, silvery-green weft beneath the vascular plants. *Cladonia* lichens can be common, and in some places in the northern Highlands and Orkney they form a conspicuous creamy-white frosting over the ground. In a few localities in the north-west Highlands there is a form of the *Cladonia* sub-community with *Juniperus communis* ssp. *nana* (A B G Averis 1994; Averis and Averis 1998a).

The *Vaccinium myrtillus* sub-community M15d is a drier and grassier assemblage, characterised by *Nardus*, *Deschampsia flexuosa*, *Juncus squarrosus* and *Vaccinium myrtillus*. This is the driest type of *Trichophorum-Erica* wet heath, and has mosses such as *Dicranum scoparium*, *Pleurozium schreberi* and *Hypnum jutlandicum*, rather than *Sphagna*.

Locally in the western Highlands there are montane wet heaths resembling the *Cladonia* and *Vaccinium* sub-communities and including northern upland species, such as *Antennaria dioica*, *Carex bigelowii*, *Diphasiastrum alpinum*, *Empetrum nigrum* ssp. *hermaphroditum*, *Vaccinium uliginosum*, the oceanic liverworts *Bazzania pearsonii* and *Anastrophyllum donnianum*, and the lichen *Cetraria islandica* (e.g. Averis and Averis 1998a; Averis and Averis 2003).

There are also stands of *Trichophorum-Erica* wet heath composed of a dense sward of *Trichophorum*, with few dwarf shrubs and almost no other species. These are mostly in places where there has been heavy grazing, especially by cattle or deer (e.g. Averis and Averis 1999a).

## DIFFERENTIATION FROM OTHER COMMUNITIES

Wet heaths, blanket mires and valley mires share a similar array of species, but the typical bog plants *Sphagnum papillosum* and *Eriophorum vaginatum* are generally rare in wet heaths. *S. papillosum* can be quite common in some stands of the *Carex* and Typical sub-communities of *Trichophorum-Erica* wet heath, but does not form the extensive sheets characteristic of *Trichophorum-Eriophorum* M17 and *Erica-Sphagnum* M18 blanket mires and *Narthecium-Sphagnum* valley mire M21.

The dry heaths *Calluna-Deschampsia* H9, *Calluna-Erica* H10 and *Calluna-Vaccinium* H12 have no *Erica tetralix* and less *Molinia* and *Trichophorum* than *Trichophorum-Erica* wet heath. The damp heaths *Calluna-Vaccinium-Sphagnum* H21 and *Vaccinium-Rubus* H22 have *Vaccinium myrtillus*, and could be confused with the *Vaccinium* sub-community of *Trichophorum-Erica* wet heath, but they have less *E. tetralix*, *Molinia* and *Trichophorum*, and more *Sphagnum capillifolium* and large pleurocarpous mosses, such as *Rhytidiadelphus loreus* and *Hylocomium splendens*. All of these dry and damp heath communities have a thicker, darker canopy of heather than *Trichophorum-Erica* wet heath.

Within the wet heaths, this community can be confused with the floristically similar *Erica-Sphagnum compactum* heath M16, the counterpart of *Trichophorum-Erica* heath in the south and east of Britain. *Sphagnum compactum* and *S. tenellum* are generally more common in the *Erica-Sphagnum compactum* community; in addition, *Potentilla erecta* is generally scarce in this form of wet heath. However, the distinction can be difficult to make in practice. For example, the NVC floristic tables for the Typical sub-community of *Trichophorum-Erica* wet heath and the *Succisa-Carex* sub-community of *Erica-Sphagnum compactum* wet heath M16b are so similar that some stands of vegetation could be equally well classified as either of these two types. There are also important floristic and ecological divisions among the range of upland wet heath vegetation in Britain that are not aligned with the distinction between the two NVC communities. One such division is between the heathy soligenous mires or flushes (the *Carex* sub-community of *Trichophorum-Erica* heath and the *Rhynchospora-Drosera* sub-community of *Erica-Sphagnum compactum* heath M16c) and the less consistently waterlogged true wet heaths belonging to the other sub-communities. *Carex* species, *Drosera* species, *Pinguicula* species, *Rhynchospora alba* and *Eleocharis multicaulis* can all be common in the soligenous mires but are scarce in the true wet heaths.

In the western Highlands it is possible to confuse the *Cladonia* sub-community of *Trichophorum-Erica* wet heath with *Calluna-Cladonia* heath H14, *Calluna-Racomitrium* heath H14 and the *Racomitrium* sub-community of *Nardus-Galium* grassland U5e. *Calluna-Cladonia* and *Calluna-Racomitrium* heaths have prostrate or severely wind-pruned heather, more montane species, and rarely much *E. tetralix*, *Trichophorum* or *Sphagnum* species. The *Racomitrium* sub-community of *Nardus-Galium* grassland has more *Nardus* than *Trichophorum* and generally has some montane species.

## ECOLOGY

*Trichophorum-Erica* wet heath is a community of shallow, wet or intermittently waterlogged, acid peat or peaty mineral soils on hillsides, over moraines, and within tracts of blanket mire. It also extends on to deep peat where the original bog vegetation has been damaged or modified by burning, grazing, drainage and peat cutting. The sub-communities occupy different terrain: the more soligenous *Carex* sub-community occurs in hollows, channels and soakways, the Typical sub-community on shallow slopes at low to moderate altitudes, the *Cladonia* sub-community on steeper slopes with thinner peat and at higher elevations, and the *Vaccinium* sub-community on drier substrates. Most stands with *Schoenus nigricans* are close to the west coast, where nutrient enrichment from sea-spray may allow *S. nigricans* to grow in otherwise acid heaths. The species-poor *Calluna-Molinia* form of the Typical sub-community typically occurs in places that are recovering from moderate to heavy grazing. Most stands of *Trichophorum-Erica* wet heath are at low to moderate altitudes, within the altitudinal range of woodland, but the *Cladonia* and *Vaccinium* sub-communities can occur at well over 600 m in the hills of the west Highlands.

## DISTRIBUTION

*Trichophorum-Erica* wet heath is widespread in the north and west of Britain. It is most common in the western Highlands, where the Typical and *Cladonia* sub-communities cover very large areas. It is common but much less extensive in the eastern Highlands, the Southern Uplands, the Cheviot Hills, the Lake District, Wales and south-west England. It is not recorded in the Pennines, but does occur in the North York Moors.

Within Europe, *Trichophorum-Erica* wet heath has a strongly oceanic distribution and is rare outside Britain and Ireland. Similar heaths occur in mainland western Europe from Sweden to Spain, but large stands are rare.

### ***Erica tetralix-Sphagnum compactum* wet heath (M16)**

#### DESCRIPTION

This type of vegetation includes the wet heaths of the south and east of Britain. They have a short grey to brown-yellow sward of *Calluna vulgaris*, *Erica tetralix* and *Molinia caerulea*, with a patchy underlay of *Sphagnum compactum* and in some places *S. tenellum*. The vegetation can have a bleak, drab look, and it is easy to imagine that Shakespeare's 'blasted heath' where Macbeth met the three witches, was a stand of this type of vegetation.

There are four sub-communities. The Typical sub-community M16a has no particular distinguishing characteristics of its own. In the *Succisa pratensis-Carex panicea* sub-community M16b *S. compactum* is scarce and there is much *Potentilla erecta*, *Succisa pratensis* and *Sphagnum denticulatum*, and, in some places, *Polygala serpyllifolia* and *Carex panicea*. The *Rhynchospora alba-Drosera intermedia* sub-community M16c is essentially a soligenous mire of wetter peats, and has *Kurzia pauciflora*, *Drosera intermedia*, *D. rotundifolia* and *Rhynchospora alba*. The *Juncus squarrosus-Dicranum scoparium* sub-community M16d is the most common form in the north of Britain, and has *Juncus squarrosus*, *Dicranum scoparium*, *Hypnum jutlandicum*, *Racomitrium lanuginosum*, *Cladonia portentosa* and *C. uncialis* ssp. *biuncialis*.

#### DIFFERENTIATION FROM OTHER COMMUNITIES

Like *Trichophorum-Erica* wet heath, *Erica-Sphagnum compactum* wet heath can be distinguished from the bog vegetation types *Trichophorum-Eriophorum* M17, *Erica-Sphagnum papillosum* M18, *Calluna-Eriophorum* M19, *Eriophorum vaginatum* M20 and *Narthecium-Sphagnum* M21 by the scarcity or absence of *Sphagnum papillosum* and *Eriophorum vaginatum*. In addition, *S. compactum* is common in *Erica-Sphagnum compactum* heath but rare in the bog communities. Separation of the two wet heath types is based mainly on *S. compactum* and *S. tenellum* being commoner in *Erica-Sphagnum compactum* heath, and *Potentilla erecta* being commoner in *Trichophorum-Erica* heath. The relationship between the two communities is discussed in more detail under *Trichophorum-Erica* wet heath (see p xx). In south-west England, *Erica-Sphagnum compactum* wet heath may occur in association with the wetter forms of *Ulex gallii-Agrostis* heath H4, from which it differs in having more *S. compactum* and little or no *Erica cinerea*, *Ulex gallii* and *Agrostis curtisii*.

#### ECOLOGY

*Erica-Sphagnum compactum* wet heath typically occurs on shallow acid peat on sloping ground, although it can cover almost level ground in the eastern Highlands and in south-west England. The soils are moist and intermittently waterlogged. It is primarily a lowland community, but occurs above 500 m in the eastern Highlands where it can cover deep peats that one might expect to be clothed with *Calluna-Eriophorum* or *Erica-Sphagnum papillosum* blanket mires. It seems that the change from bog to wet heath has been caused by frequent or severe burning and heavy grazing and trampling. Most examples of *Erica-Sphagnum compactum* wet heath are semi-natural, but there are perhaps near-natural stands at high altitudes in the Cairngorms, where it occurs in hollows among montane *Calluna-Cladonia* heath H13.

#### DISTRIBUTION

This community replaces *Trichophorum-Erica* wet heath in the drier, more continental climate of the south and east. It is widespread but rather scarce in lowland Britain, and extends into upland areas in eastern Scotland, the Pennines, the North York Moors, south-west England, and parts of Wales. It is particularly common in the eastern Highlands and the North York Moors.

Vegetation resembling *Erica-Sphagnum compactum* wet heath is confined to the oceanic fringes of Europe between western Norway and Spain.

### ***Trichophorum cespitosum-Eriophorum vaginatum* blanket mire (M17)**

#### DESCRIPTION

The pale ochre-gold sheets of this mire are composed of *Eriophorum vaginatum*, *E. angustifolium*, *Trichophorum cespitosum* and *Molinia caerulea*, dotted with darker clumps of *Calluna vulgaris* and *Erica tetralix*. Beneath the vascular plants there are shallow spongy mats of *Sphagnum papillosum* and *S. capillifolium*. Small vascular plants prick up through the layer of mosses: the red-gold spikes of *Narthecium*

*ossifragum*, the red, sticky rosettes of *Drosera* species, the trailing, rich-green shoots of *Potentilla erecta*, and in some places the stiff green leaves of *Dactylorhiza maculata* with its conspicuous spotted pale lilac flowers in early summer.

Small-scale variation in the species composition of this mire type is described by Lindsay (1995). The mire surface is corrugated into a system of pools and hummocks, each with characteristic assemblages of Sphagna and other plants. Some of the pools belong to the *Sphagnum denticulatum* bog pool community M1 or the *Sphagnum cuspidatum/fallax* bog pool community M2, but the vegetation of larger lochans and smaller hollows is not described in the NVC. The largest pools occur in the north and west of Scotland, where up to 50% of the mire surface may be open water. The pools can form spectacular ladder-systems on gentle slopes and reticulate patterns on shallow domes.

There are three sub-communities, corresponding to variation in the wetness of the peat. The *Drosera rotundifolia*-*Sphagnum* species sub-community M17a occurs in the most consistently wet conditions. *Drosera* species are especially common here, and *Sphagnum papillosum* and *S. capillifolium* cover most of the peat surface. *Myrica gale*, with its grey-green sweet-scented leaves, can grow thickly in this type of mire, and in Scottish stands there can be purple-red tufts of the oceanic liverwort *Pleurozia purpurea*. In the west Highlands and the Hebrides *Rhynchospora alba* can be common, and in a few places *Schoenus nigricans* grows on the mire surface. Where the peat is level and deep the mire surface may be broken by innumerable shining pools, forming the distinctive patterns so obvious in aerial views of the immense tracts of blanket mire in the northern and western Highlands. The *Cladonia* species sub-community M17b occurs on slightly drier peats, for example where the surface has been dried out by burning. Like the *Cladonia* sub-community of *Trichophorum-Erica* wet heath M15c, its name is deceptive, as in many places it is the moss *Racomitrium lanuginosum*, rather than *Cladonia* lichens, that defines this sub-community. *R. lanuginosum* grows in silvery-green patches and low hummocks which are often visible from afar, giving the mire a distinctive knobbed appearance. Sphagna are scarcer here, as are bog plants, such as *Drosera* species. Lichens are common, and in the far north-west Highlands can grow thickly enough to make the vegetation look as if it is sprinkled with snow; the usual species are *Cladonia arbuscula*, *C. portentosa* and *C. uncialis* ssp. *biuncialis*. The *Juncus squarrosus*-*Rhytidiadelphus loreus* sub-community M17c is characteristic of drier peats and is mostly at higher altitudes. It has a mixed and tussocky sward, thick with the stout green rosettes of *Juncus squarrosus*, pale tufts of *Nardus stricta*, and pleurocarpous mosses, such as *Rhytidiadelphus loreus*, *Pleurozium schreberi*, *Hylocomium splendens* and *Hypnum jutlandicum*, as well as the characteristic Sphagna. There can also be a little *Vaccinium myrtillus* and *Deschampsia flexuosa*.

#### DIFFERENTIATION FROM OTHER COMMUNITIES

This is an ombrogenous mire community. It can be distinguished from wet heaths, which are composed of a similar set of species, by *Eriophorum vaginatum* and peat-building Sphagna, such as *Sphagnum papillosum*. Of the other ombrogenous mires, *Erica-Sphagnum papillosum* mire M18 most closely resembles *Trichophorum-Eriophorum* blanket mire, but on the deep, soft and strongly saturated peats that are the most characteristic habitat of *Erica-Sphagnum papillosum* mire there is generally less *Trichophorum*, *Potentilla erecta* and *Molinia*, and more *Sphagnum tenellum* and *Odontoschisma sphagni*. There is also usually more *Erica tetralix* in *Erica-Sphagnum papillosum* mire, giving a greyish tone to the vegetation, especially in stands with very little *Calluna*, and the carpet of Sphagna is typically more continuous. The wetter *Sphagnum-Andromeda* sub-community M18a is further distinguished from *Trichophorum-Eriophorum* mire by the presence of *Sphagnum magellanicum* and *Vaccinium oxycoccos* in many stands, and between mid Wales and southern Scotland there can be some *Andromeda polifolia* too. The *Cladonia* sub-community of *Trichophorum-Eriophorum* mire can closely resemble the *Empetrum-Cladonia* sub-community of *Erica-Sphagnum papillosum* mire M18b, but has less *Empetrum nigrum*, and usually more *Molinia* and *Trichophorum*.

Despite what has just been said, the separation of *Trichophorum-Eriophorum* mire and *Erica-Sphagnum papillosum* mire can be difficult. The situation is confused by treating *V. oxycoccos* and *Andromeda* as indicators of the *Sphagnum-Andromeda* sub-community of *Erica-Sphagnum papillosum* mire. These are scarce species, and although they are commonest on the wet, soft peat surfaces of this form of mire they can also occur in quantity on less strongly waterlogged peat in the *Empetrum-Cladonia* sub-community of *Erica-Sphagnum papillosum* mire, in *Calluna-Eriophorum* blanket bog M19, and in vegetation with much *Trichophorum* that otherwise resembles *Trichophorum-Eriophorum* mire. Perhaps these two species should be regarded as characteristic of geographical variants of various sub-communities of *Trichophorum-Eriophorum*, *Erica-Sphagnum papillosum* and *Calluna-Eriophorum* mires.

The *Erica* sub-community of *Calluna -Eriophorum* mire M19a shares some of the species of *Trichophorum-Eriophorum* mire: *Erica tetralix*, *Trichophorum*, *Hypnum jutlandicum*, and, in some stands, *Narthecium* and *Molinia*. Here, however, they are set in a dense dark, tussocky sward of *Calluna* and *Eriophorum vaginatum* lacking the sheets of *Sphagnum papillosum* that are typical of *Trichophorum-Eriophorum* mire. Drier stands of the *Cladonia* sub-community of *Trichophorum-Eriophorum* mire may have little *S. papillosum* and much *S. capillifolium*; they have more *Trichophorum* than *Calluna-Eriophorum* mire and less *Rhytidiadelphus loreus*, *Hylocomium splendens*, *Plagiothecium undulatum* and other pleurocarpous mosses.

The *Juncus-Rhytidiadelphus* sub-community of *Trichophorum-Eriophorum* mire can be confused with the *Sphagnum* sub-community of *Juncus-Festuca* grassland U6a, which shares the same habitat of shallow peats on plateaux, and which can have large amounts of *S. papillosum* and *S. capillifolium*. However, *Juncus-Festuca* grassland usually has much more *Juncus squarrosus* and *Festuca ovina*, and smaller quantities of *Calluna*, *E. tetralix* and bog plants, such as *E. vaginatum*, *Drosera* species and *Narthecium*.

Where grazing and burning have suppressed the dwarf shrubs, *Trichophorum-Eriophorum* mire can resemble *Eriophorum angustifolium* mire M3, *Eriophorum vaginatum* mire M20 or *Molinia-Potentilla* mire M25. Dwarf shrubs and *Sphagna* are co-dominant or at least very common in *Trichophorum-Eriophorum* mire, whereas in the other vegetation types *Eriophorum* species or *Molinia* are clearly dominant, and dwarf shrubs are either absent or very sparse indeed.

#### ECOLOGY

*Trichophorum-Eriophorum* mires are characteristic of the mild and wet climate of the western uplands. Rainfall exceeds evapotranspiration, the soils become waterlogged and anaerobic, and the dead remains of plants eventually form a thick layer of peat. This insulates the vegetation from the underlying rock and from ground water, and almost all nutrients are received from mist, rain and snow. Whole landscapes can become enveloped in peat, and *Trichophorum-Eriophorum* mire can be the prevailing type of vegetation over many square kilometres. Most stands are on level ground or gentle slopes, but in the Outer Hebrides and in north-west Sutherland the community clothes surprisingly steep slopes, perhaps because the climate is so cool and wet that deep, waterlogged peat can accumulate even on sloping ground. The peat is acid, with a pH of about 4 (McVean and Ratcliffe 1962; Rodwell 1991b). In the western Highlands, *Trichophorum-Eriophorum* mire is most common below about 450 m, but further east and south it occurs mainly at slightly higher elevations. The upper altitudinal limit of the *Juncus-Rhytidiadelphus* sub-community is over 850 m (Rodwell 1991b). On Dartmoor in south-west England, the community occurs on the high plateau above 450 m, a habitat analogous to that of *Calluna-Eriophorum* mire in the Pennines.

#### DISTRIBUTION

*Trichophorum-Eriophorum* mire is widespread in upland areas of western Britain. It is most common and extensive in the western and northern Highlands and the Hebrides. It also occurs in the eastern Highlands, Galloway, the Lake District, Wales, south-west England and, very sparingly, in the north Pennines.

A related form of blanket mire is common in Ireland, but comparable vegetation is unknown elsewhere in Europe.

### ***Erica tetralix-Sphagnum papillosum* raised and blanket mire (M18)**

#### DESCRIPTION

This type of mire consists of a sparse low sward of *Erica tetralix*, *Calluna vulgaris*, *Eriophorum angustifolium*, *E. vaginatum* and in some places *Trichophorum cespitosum* standing over a varied carpet of bryophytes and lichens. As in the *Trichophorum-Eriophorum* mire M17, the mire surface can be crinkled into a series of hummocks and hollows, each with its typical *Sphagna* and other plants (see p xx).

There are two sub-communities. The *Sphagnum magellanicum-Andromeda polifolia* sub-community M18a occupies saturated peats. It has an almost continuous carpet of *Sphagna*: the ochre *S. papillosum*, the rich red *S. capillifolium*, the pale-green *S. tenellum* and *S. cuspidatum*, and in many stands the fat-leaved, wine-red *S. magellanicum*. The *Sphagna* usually grow with a few common pleurocarpous mosses and with a sprinkling of *Aulacomnium palustre* and tufts of *Polytrichum strictum*. The layer of mosses is pierced by the sharp curved leaves of *Narthecium ossifragum* and speckled with the sticky red rosettes of *Drosera* species. In many stands the thin dark stems and shiny oval leaves of *Vaccinium oxycoccos* creep in a wiry tangle over the mosses; the surprisingly large pink flowers are a cheering sight in early summer. In Wales, northern England and southern Scotland, the *Sphagnum-Andromeda* sub-community is home to the scarce

*Andromeda polifolia* with its upright shoots bearing narrow grey-green leaves. In the drier *Empetrum nigrum* ssp. *nigrum*-*Cladonia* sub-community M18b there can be much *Empetrum nigrum* ssp. *nigrum*, although this species is also common in some stands of the *Sphagnum*-*Andromeda* sub-community. Sphagna are scarcer in the *Empetrum*-*Cladonia* sub-community, and there can be a thin frosting of *Cladonia* lichens, as well as more continuous carpets of large pleurocarpous mosses, such as *Rhytidiadelphus loreus* and *Pleurozium schreberi*. In some stands *Racomitrium lanuginosum* grows in silver-green patches and hummocks on the peat. Bogs belonging to this sub-community can be rather hagged.

#### DIFFERENTIATION FROM OTHER COMMUNITIES

This community is most likely to be confused with *Trichophorum-Eriophorum* blanket mire M17, as the two communities share a similar set of species (see p xx). Some stands of *Erica-Sphagnum papillosum* mire have a dense dark sward of *Calluna* and *Eriophorum vaginatum* in which *Erica tetralix* is less common than usual, and look more like *Calluna-Eriophorum* mire M19 from a distance. However, at close quarters, the *Erica-Sphagnum papillosum* mire has *Sphagnum papillosum* and in many places *S. magellanicum* mixed with other Sphagna under the heather, rather than just *S. capillifolium*, as is typical in *Calluna-Eriophorum* mire. *Drosera rotundifolia* and *Narthecium* are also much more characteristic of *Erica-Sphagnum papillosum* mire.

#### ECOLOGY

*Erica-Sphagnum papillosum* mire occurs on deep, wet, ombrogenous peat. It is the characteristic plant community of raised mires in the lowlands, but also occurs in the uplands in basins and on concave slopes as well as on level, poorly-drained plateaux. Here it usually forms mosaics with *Calluna-Eriophorum* blanket mire and *Eriophorum vaginatum* mire M20, marking out localised areas of deep saturated peat on cols and in shallow hollows. Blanket mire forms of the community occur from low altitudes to over 500 m. The thick layer of peat insulates the vegetation from the underlying rock, so the mire can occur over any substrate from limestone to granite. The peat has a pH of around 4.0 (Rodwell 1991b) and is largely composed of *Sphagnum* remains.

#### DISTRIBUTION

The community is widespread but local from Wales north to Orkney in both upland and lowland Britain. It is most common in Sutherland, Caithness, southern Scotland, northern England and Wales.

There is similar vegetation in the lowlands of western Europe and in Ireland.

### ***Calluna vulgaris-Eriophorum vaginatum* blanket mire (M19)**

#### DESCRIPTION

These are mires with a dense, shaggy, purple-brown and dark-green, tussocky sward of *Calluna vulgaris* and *Eriophorum vaginatum*, speckled with the long, shining, deep-green leaves of *E. angustifolium*, straggling shoots of *Vaccinium myrtillus*, and low clumps of *Empetrum nigrum* ssp. *nigrum*. Over the ground there is a deep rich-red-gold quilt of *Sphagnum capillifolium*, *S. subnitens* and large mosses, such as *Hylocomium splendens*, *Pleurozium schreberi*, *Hypnum jutlandicum*, *Rhytidiadelphus loreus* and *Plagiothecium undulatum*. In many places the vegetation is broken by hags, with great spreads of bare peat, especially in larger stands. The hummocks, hollows and pools characteristic of the wetter *Trichophorum-Eriophorum* M17 and *Erica-Sphagnum papillosum* M18 blanket mires are rare in *Calluna-Eriophorum* vegetation but do occur locally, for example in the Inner Hebrides and on Orkney.

Three sub-communities are described in the NVC, but they do not represent the most obvious patterns of floristic and ecological variation among British *Calluna-Eriophorum* mires. In broad terms, the sub-communities form a series from oceanic, southern or western vegetation to northern, boreal and montane vegetation. The *Erica tetralix* sub-community M19a, which descends to the lowest altitudes and is the most common form in the far west, has *Erica tetralix*, *Trichophorum cespitosum* and *Molinia caerulea*, in some places with a sprinkling of *Narthecium ossifragum* or *Drosera rotundifolia*; *Rubus chamaemorus* is generally absent. The moss *Hypnum jutlandicum* is listed as a characteristic species of this sub-community in the NVC table, but it is so common in *Calluna-Eriophorum* mire generally that it cannot be used as an indicator of any particular sub-type. It also seems likely that most of the records of *H. cupressiforme* in the NVC table actually refer to *H. jutlandicum*. The more northern and boreal *Empetrum nigrum* ssp. *nigrum* sub-community M19b is defined in the NVC as having more *Empetrum nigrum* ssp. *nigrum*, with less of the species which define the *Erica* sub-community. However, *E. nigrum* ssp. *nigrum* is also common in the *Erica* sub-community, blurring the distinction between the two types. *R. chamaemorus* can be common in the *Empetrum* sub-community. Although it is a deciduous herb, the dead leaves persist under the canopy all winter in brown drifts which are

still conspicuous in spring when the new leaves start to unfurl. The *Vaccinium vitis-idaea-Hylocomium splendens* sub-community M19c takes in an assortment of more northern or montane mires, generally with *Vaccinium vitis-idaea*, *V. myrtillus*, *Empetrum nigrum* ssp. *hermaphroditum*, and *Cladonia arbuscula*. *Sphagnum fuscum* can be common here, and there can also be a few montane species, such as *Carex bigelowii*, *Vaccinium uliginosum*, *Polytrichum alpinum* and *Cetraria islandica*. At the highest altitudes *E. nigrum* ssp. *hermaphroditum* takes the place of *Calluna*, growing in a distinctive low, bright-green sward. The rare shrub *Betula nana* occurs locally in this sub-community at moderate to high altitudes. In some stands in the northern and eastern Highlands, *Cladonia* lichens grow thickly enough to make the ground under the vascular plants look as if it is dusted with snow (McVean and Ratcliffe 1962).

Locally in Wales there are small patches of bog with a canopy of *Calluna* and *E. vaginatum* over a ground layer that resembles *Carex echinata-Sphagnum* mire M6 in comprising *Sphagnum fallax* and *Polytrichum commune*. This vegetation is not described in the NVC. Although it has a superficial resemblance to *Calluna-Eriophorum* mire it may actually be derived from *Erica-Sphagnum papillosum* bog.

#### DIFFERENTIATION FROM OTHER COMMUNITIES

*Calluna-Eriophorum* mire as a whole is a well-defined and distinct type of vegetation. Stands of *Erica-Sphagnum papillosum* mire with a thick canopy of *Calluna* and rather little *Erica tetralix* can resemble it from a distance, but are very different at close quarters (see p xx). The *Erica* sub-community of *Calluna-Eriophorum* mire shares several species with *Trichophorum-Eriophorum* mire, but the two communities usually look very different. *Calluna-Eriophorum* mire has a dark-coloured, tussocky sward of *Calluna* and *Eriophorum vaginatum*, whereas *Trichophorum-Eriophorum* mire consists of pale, open spreads of graminoids and Sphagna. *E. tetralix*, *Trichophorum*, *Molinia* and *Sphagnum papillosum* are all more common in *Trichophorum-Eriophorum* mire than they are in *Calluna-Eriophorum* mire. The *Calluna-Cladonia* sub-community of *Eriophorum vaginatum* mire M20b has much in common with *Calluna-Eriophorum* mire, but the balance between dwarf shrubs and *E. vaginatum* is quite firmly tipped to the side of the *Eriophorum*, *Calluna* is patchy and sparse, and there is usually less *Sphagnum*. *Calluna-Eriophorum* mire has more *E. vaginatum* and Sphagna than *Trichophorum-Erica* M15 and *Erica-Sphagnum compactum* M16 wet heaths. Forms of *Calluna-Eriophorum* mire with carpets of *Sphagnum capillifolium* and pleurocarpous mosses under the *Calluna* have much in common with *Calluna-Vaccinium-Sphagnum* H21 and *Vaccinium-Rubus* H22 damp heaths. However, the blanket bog occurs on deeper peat and has more *E. vaginatum*. This species occurs as sparse tufts, if at all, in the damp heath communities, and it is never co-dominant with *Calluna*. *E. vaginatum* also serves to distinguish the form of the *Vaccinium-Hylocomium* sub-community that is dominated by *Empetrum nigrum* ssp. *hermaphroditum* from *Sphagnum*-rich forms of *Vaccinium-Racomitrium* heath H20.

#### ECOLOGY

*Calluna-Eriophorum* mire covers watersheds and gentle slopes where a deep layer of peat has been able to accumulate. It occurs on drier peats than either *Trichophorum-Eriophorum* mire or *Erica-Sphagnum papillosum* mire. Although the mire surface can be ragged with hags and wet peaty channels containing *Eriophorum angustifolium*, there are rarely the pools and hollows characteristic of wetter mires, nor is there often water lying over the peat surface. The peat itself is generally firm, moist and fibrous rather than wet and slimy.

*Calluna-Eriophorum* mire is a more northern, boreal and montane type of vegetation than *Trichophorum-Eriophorum* mire. Although it occurs locally below 100 m in north-west Scotland, most stands are at higher altitudes. In the west of Britain, it generally replaces *Trichophorum-Eriophorum* mire above about 350 m. The more montane forms of the *Vaccinium-Hylocomium splendens* sub-community extend the altitudinal range of the community to over 900 m on the high plateaux of the Cairngorms, Lochnagar and Caenlochan.

#### DISTRIBUTION

*Calluna-Eriophorum* mire occurs throughout the British uplands from Wales northwards. Extensive tracts of the community occur in the central and eastern Highlands and in the northern Pennines and the Cheviot. There are also large stands on the stepped basalt hills of Skye and Mull. In the rugged hills of the west Highlands and further south in the Lake District and Wales, *Calluna-Eriophorum* mire tends to occur in smaller stands. In south-west England its place is taken by *Trichophorum-Eriophorum* mire. In the southern Pennines, which have a long history of burning, grazing and air pollution, much *Calluna-Eriophorum* vegetation has been replaced by *Eriophorum vaginatum* mire M20.

There is vegetation similar to *Calluna-Eriophorum* mire in western and central Norway but the stands are small (Lindsay 1995).

## ***Eriophorum vaginatum* blanket and raised mire (M20)**

### DESCRIPTION

*Eriophorum vaginatum* mire is an unprepossessing, scruffy form of vegetation, comprising impoverished, grey-green expanses of tussocky *E. vaginatum*, dotted in summer with its white feathery fruiting heads like flakes of snow. There are few other species.

There are two sub-communities. The Species-poor sub-community M20a is a bleak, patchy sward made up of tussocks of *E. vaginatum* intermingled with shoots of *E. angustifolium* and in some places a little *Deschampsia flexuosa*. The peat surface is typically glazed with a thin crust of algae and can be furred over with the silvery shoots of the introduced moss *Campylopus introflexus*. The *Calluna vulgaris*-*Cladonia* species sub-community M20b is a little less dreary. The pale tussocky swards of *E. vaginatum* are enlivened by *Vaccinium myrtillus*, *Empetrum nigrum* ssp. *nigrum*, and in some places grazed, distorted shoots of *Calluna*. The tussocks of *E. vaginatum* are interleaved with grasses, especially *Agrostis canina*, *Nardus stricta* and *Deschampsia flexuosa*, and there can be conspicuous patches of the lichen *Cladonia arbuscula*.

It is quite common to find bogs dominated by *E. vaginatum* that do not correspond well to either sub-community. In some bogs the tussocks of *E. vaginatum* are overgrown with great masses of *Hypnum jutlandicum* and *Pleurozium schreberi*. Another type has much *Sphagnum papillosum*, *S. capillifolium* and *Polytrichum strictum*, and in some places scattered shoots of *Vaccinium oxycoccos* or *Andromeda polifolia*; this appears to be derived from *Erica-Sphagnum papillosum* mire M18. A third type has a moss layer composed mainly of *Sphagnum fallax* and *Polytrichum commune*, as in *Carex echinata*-*Sphagnum* mire M6.

### DIFFERENTIATION FROM OTHER COMMUNITIES

The dominance of *Eriophorum vaginatum* means that this vegetation type can only be an ombrogenous mire. This distinguishes it from wet and dry heath communities. The species-poor sub-community can hardly be mistaken for any other type of vegetation. The *Calluna-Cladonia* sub-community may be confused with *Calluna-Eriophorum* mire M19, but has less *Calluna* and almost no Sphagna. The other types of *Eriophorum vaginatum*-dominated bog described above are distinguished from other bog communities by the dominance of *E. vaginatum* and the scarcity of dwarf shrubs.

### ECOLOGY

This is blanket mire pushed by grazing, burning, drainage and atmospheric pollution near to the point of no return. *Eriophorum vaginatum* mires covers watersheds and gentle slopes, level plateaux and peat-filled hollows: terrain where *Calluna-Eriophorum* mire would be the more natural type of mire on drier peats and *Erica-Sphagnum papillosum* mire in more saturated situations. It occurs from about 300 m up to over 900 m in Scotland. Many stands in the southern Pennines are broken by vast tracts of bare, hagged, peat, memorably described as a landscape looking as if it was covered in the droppings of dinosaurs (Hillaby 1970). This is thought to be the result of many years of sheep grazing, accidental fires, atmospheric pollution and erosion, perhaps exacerbated by burning for management purposes. The vegetation was frequently set on fire by Second World War bombs which missed Sheffield and Manchester, and in some places the peat smouldered slowly for weeks.

### DISTRIBUTION

*Eriophorum vaginatum* mire is most common in the Pennines, especially in the south on the hills between the industrial towns of Yorkshire and Lancashire. It is also common in Wales and the Lake District. In Scotland it occurs more sparingly in the Southern Uplands and in the southern and eastern Highlands.

There is similar vegetation in eastern Ireland and in the most polluted regions of south-west Norway.

## ***Narthecium ossifragum-Sphagnum papillosum* valley mire (M21)**

### DESCRIPTION

These are richly-coloured, attractive stands of vegetation in shallow valleys adjoining sluggish streams. They consist of warm golden-yellow and green-yellow sheets of *Sphagnum papillosum*, *S. denticulatum* and *S. fallax*, interspersed with thick patches of *Narthecium ossifragum* with its orange-tipped leaves and golden flowers in summer, and overtopped by a thin green sward of *Molinia caerulea* and *Eriophorum angustifolium*. There are scattered bushes of *Erica tetralix* and *Calluna vulgaris*. The Sphagna are dotted with the glandular red rosettes of

*Drosera rotundifolia* and in some places are entwined with the slender stems of *Anagallis tenella*, with its light-green pairs of neat round leaves and pale pink flowers.

There are two sub-communities. The *Rhynchospora alba*-*Sphagnum denticulatum* sub-community M21a has much *S. denticulatum*, and in the summer there are usually spreads of *Rhynchospora alba*, its stems topped with sharp creamy-white flowers. *Myrica gale* is common here, as are the liverworts *Odontoschisma sphagni* and *Kurzia pauciflora*. The *Vaccinium oxycoccos*-*Sphagnum fallax* sub-community M21b has, in addition to *Vaccinium oxycoccos* and *S. fallax*, much *Potentilla erecta*, *Carex echinata*, *C. panicea* and *Aulacomnium palustre*.

#### DIFFERENTIATION FROM OTHER COMMUNITIES

*Narthecium-Sphagnum* valley mires resemble both *Trichophorum-Eriophorum* blanket mire M17 and *Erica-Sphagnum papillosum* mire M18. All three communities have extensive lawns of Sphagna under a low, open sward of vascular plants. The peat is wetter in *Narthecium-Sphagnum* vegetation than in either of the other two communities, and the dwarf shrubs are sparse and poorly-grown as a result. In contrast to raised and blanket mires, *Narthecium-Sphagnum* vegetation typically has neither *Eriophorum vaginatum* nor *Trichophorum cespitosum*. Neither does it have the surface patterning that can occur in *Trichophorum-Eriophorum* and *Erica-Sphagnum papillosum* mires, although there are pools in some of the larger stands. The community has no upland or montane species, such as *Vaccinium myrtillus* and *Rubus chamaemorus*, and also lacks the pleurocarpous mosses characteristic of *Calluna-Eriophorum* mire M19.

#### ECOLOGY

This community fills the bottoms of waterlogged valleys and hollows and rarely occurs above 200 m. It occurs on peat over impervious acid rocks, such as granite. The peat is usually less than 150 cm deep, and is acid with a pH between 3.5 and 4.5 (Rodwell 1991b). It is always saturated, so much so that unlike other upland bogs it is difficult or even impossible to walk across. The wetness is maintained by a high water-table and by streams flowing through the vegetation. Unlike blanket and raised mires, valley mires are sustained by water moving laterally through the peat as well as that supplied by rain.

#### DISTRIBUTION

*Narthecium-Sphagnum* valley mire has a patchy distribution in Britain. It forms part of the vegetation of valley mires in southern England: in lowland areas, such as the New Forest, and also in upland areas, such as Dartmoor and Exmoor (Rodwell 1991b). There are scattered records in Wales and northern England, and two outlying records from the Scottish Highlands.

There is similar vegetation in Ireland, western France, and parts of Spain and Portugal. A related type of mire with more northern species occurs locally in western Norway.

### ***Juncus effusus/acutiflorus-Galium palustre* rush-pasture (M23)**

#### DESCRIPTION

This community comprises tall, deep-green swards of *Juncus effusus* or *J. acutiflorus* or both, entwined with grasses, such as *Holcus lanatus*, *Molinia caerulea*, *Agrostis canina* and *Anthoxanthum odoratum*, the scrambling *Galium palustre*, and in most places a mixture of other mesotrophic herbs. On the wet ground under the rushes there is a thin weft of bryophytes, such as *Calliergonella cuspidata*, *Rhizomnium punctatum*, *Brachythecium rutabulum* and *Chiloscyphus polyanthos*.

There are two sub-communities, one of which is usually more species-rich than the other. The *Juncus acutiflorus* sub-community M23a is the richer form. *J. acutiflorus* predominates in the sward, although there can be a fair amount of *J. effusus* as well. Just as noticeable as the rushes are the lush spreads of tall mesotrophic forbs that grow among them. Where grazing is not too heavy they are bright with flowers in summer. Among the most common species are *Filipendula ulmaria*, *Ranunculus acris*, *R. flammula*, *Galium palustre*, *Lotus pedunculatus*, *Geum rivale*, *Angelica sylvestris*, *Mentha aquatica*, *Myosotis secunda*, *Senecio aquaticus*, *Lychnis flos-cuculi*, *Succisa pratensis* and *Valeriana officinalis*. The *Juncus effusus* sub-community M23b usually has fewer forbs. Many stands are rather grassy or weedy, with *Cirsium palustre*, *Rumex acetosa* and lowland grassland species, such as *Ranunculus repens* and *Poa trivialis*.

#### DIFFERENTIATION FROM OTHER COMMUNITIES

Most stands of *Juncus-Galium* rush-pasture are easy to distinguish from the superficially similar rush-dominated sub-communities of *Carex echinata-Sphagnum* mire M6c and M6d, because they generally lack acidophilous Sphagna and *Polytrichum commune*. The most herb-rich stands of the *Juncus acutiflorus* sub-community might

be confused with *Filipendula-Angelica* mire M27 or *Iris-Filipendula* mire M28. However, these mire types are dominated by *Filipendula ulmaria* and *Iris pseudacorus* respectively; although these plants grow in *Juncus acutiflorus*-dominated forms of *Juncus-Galium* rush-pasture, they are part of a diverse mixture of species and are not dominant. *J. acutiflorus*, *J. effusus* and many of the small forbs typical of *Juncus-Galium* rush-pasture occur in some forms of *Molinia-Potentilla* mire M25 and *Molinia-Crepis* mire M26, but in these communities *Molinia* is commoner than *Juncus* species and is usually dominant, whereas in *Juncus-Galium* vegetation it is less common than the rushes. The *Juncus effusus* sub-community of *Juncus-Galium* rush-pasture can be similar to the Typical sub-community of *Holcus-Juncus* rush-pasture MG10a, but fen species, such as *Galium palustre*, *Lotus pedunculatus*, *Cirsium palustre* and *Ranunculus flammula*, and the moss *Calliergonella cuspidata*, are more common. However, some species-poor vegetation dominated by *Juncus effusus* cannot be assigned clearly to either community.

#### ECOLOGY

The dark-green, spiky-leaved swards of these mires are easy to pick out on gently-sloping hillsides, along the margins of streams, and in marshy valleys. In the western Highlands and the Inner Hebrides, *Juncus-Galium* rush-pasture is common on level marshy ground close to the shore. Both types, but especially the *Juncus effusus* sub-community, are also common in neglected damp pastures and in ditches around fields and settlements in the upland margins. The community is sub-montane and occurs from high-tide level in the western Highlands to just over 400 m. In northern Scotland it is rare above 200 m.

*Juncus-Galium* rush-pasture occurs on peaty mineral soils and stagnogleys, often with a strong smell of decomposing vegetation. The soils are acid to neutral with a pH between 4 and 6. They are kept wet throughout the year by flushing and seepage, and there can be some standing water in winter. The *Juncus acutiflorus* sub-community tends to occur on wetter substrates than the *Juncus effusus* sub-community.

#### DISTRIBUTION

*Juncus-Galium* rush-pasture occurs throughout the west and north of Britain from Cornwall to Orkney. In the uplands it is especially common in south-west Scotland and the Inner Hebrides, and is scarce in the northern Highlands, the southern Pennines and the North York Moors. The richer *Juncus acutiflorus* sub-community is especially common over the basic Dalradian rocks of the western Breadalbanes, the basalt of Mull and Skye, and the limestone of Lismore (e.g. Averis and Averis 1995a, 1995b, 1996, 1999a, 1999b).

There is similar vegetation in Ireland, France, Spain and Portugal but not in Scandinavia nor apparently further east in Europe.

### ***Molinia caerulea-Potentilla erecta* mire (M25)**

#### DESCRIPTION

These are the wet grasslands that can make walking in the hills of Wales, Galloway and the western Highlands and Inner Hebrides so wearisome. The tall dense tussocks of *Molinia caerulea*, with long leaves blown into waves by the wind and rain, conceal a treacherous network of peaty channels and in some places small winding streams. The grasslands look attractive in summer, with the long, lax *Molinia* leaves in shades of silvery green, but in winter the leaves collapse into dun-coloured, dank arrays of tussocks. There is usually a little *Potentilla erecta*, well-hidden beneath the *Molinia*. The habitat can be very diverse on a fine scale, with different species growing on the upper parts of *Molinia* tussocks, the sides of older tussocks and on the ground in between the tussocks.

Three sub-communities are described in the NVC: one heathy, one grassy and one herb-rich. The *Erica tetralix* sub-community M25a is the heathy form and also the most common of the three. Here *Erica tetralix* and a little *Calluna vulgaris* dot the sea of *Molinia*. There are usually a few other bog species too, such as *Eriophorum angustifolium*, *Myrica gale*, *Trichophorum cespitosum* and Sphagna. The *Anthoxanthum odoratum* sub-community M25b has a more mixed sward of grasses with *Anthoxanthum odoratum*, *Agrostis canina*, *Nardus stricta*, *Festuca ovina* and *Holcus lanatus* interleaved in the sward of *Molinia*. Other typical species include *Luzula multiflora*, *Succisa pratensis* and *Viola palustris*. The *Angelica sylvestris* sub-community M25c is moderately herb-rich and tends to cover wetter soils than the *Anthoxanthum* sub-community. Among the tussocks of *Molinia* there is a sprinkling of poor-fen forbs, such as *Angelica sylvestris*, *Geum rivale*, *Valeriana officinalis*, *Filipendula ulmaria*, *Mentha aquatica*, *Succisa pratensis*, *Parnassia palustris* and *Caltha palustris*. Where grazing is not too heavy the swards can be quite a colourful sight in summer. Some flushes and damp cliff ledges in the Hebrides hold vegetation co-dominated by *Molinia* and *Schoenus nigricans*; this can be classed as a distinctive, extremely oceanic form of the *Angelica* sub-community.

There are also vast tracts of very impoverished *Molinia* grassland, especially in the Southern Uplands and Wales. They have so few species other than *Molinia* that the vegetation cannot be assigned to any of the three sub-communities.

#### DIFFERENTIATION FROM OTHER COMMUNITIES

These *Molinia* grasslands are quite distinctive. Their flora and structure separate them from most other types of upland vegetation. *Molinia* can be very common in *Trichophorum-Erica* wet heath M15, *Erica-Sphagnum compactum* wet heath M16 and *Trichophorum-Eriophorum* mire M17, but in these communities it is usually mixed with *Erica tetralix*, *Calluna*, *Trichophorum cespitosum* and *Sphagna*, rather than dominating the sward as it does in *Molinia-Potentilla* mire. *Molinia*-rich stands of *Trichophorum-Eriophorum* mire and other forms of blanket bog have much *Sphagnum capillifolium*, *S. papillosum* and *Eriophorum vaginatum*, and usually have a thicker canopy of dwarf shrubs than *Molinia-Potentilla* mire.

*Molinia-Crepis* mire M26 might be confused with the herb-rich *Angelica* sub-community, but is generally a richer assemblage of species, with more *Crepis paludosa*, *Valeriana dioica*, *Sanguisorba officinalis* and *Briza media*.

The *Molinia-Potentilla* community straddles a major division between two broad types of *Molinia* vegetation: the acidic and boggy *Erica* sub-community on the one hand and the herb-rich *Angelica* sub-community on the other. In many ways the *Angelica* sub-community is closer to *Molinia-Crepis* mire than to the *Erica* sub-community. The third British *Molinia*-dominated community described in the NVC is the lowland *Molinia caerulea-Cirsium dissectum* fen-meadow M24, which is distinguished primarily by *Cirsium dissectum*. However, its three sub-communities also span this same broad division between boggy and herb-rich types.

#### ECOLOGY

*Molinia-Potentilla* mire is a grassland of shallow wet peats on concave slopes, peaty mineral soils and wet gleyed muds. It can cover huge areas of ill-drained hillsides, fill the level floors of glens and valleys, or occur in narrow linear stands along the sides of streams. It is predominantly a community of the upland fringes but can occur up to almost 600 m in the mild oceanic climate of Wales, the west Highlands and the Hebrides.

The soils are usually acid, with a pH ranging from 4.0 to 5.5, although the herb-rich *Angelica* sub-community shows signs of moderate nutrient enrichment, and is locally common on basalt and other basic rocks in the western Highlands and on Mull and Skye. The soils are well-aerated and are kept wet by moving water, although stands can be inundated in winter.

#### DISTRIBUTION

*Molinia-Potentilla* mire occurs throughout the western uplands from Cornwall northwards, and is particularly extensive in Wales, Galloway and parts of the western Highlands. It has not been recorded in Orkney or Shetland, and is scarce in the Outer Hebrides, the North York Moors and parts of the Pennines. It is widely distributed in lowland Britain, especially in the west.

There are similar *Molinia*-dominated grasslands in western Ireland but Britain is the world headquarters for this type of vegetation.

### ***Molinia caerulea-Crepis paludosa* mire (M26)**

#### DESCRIPTION

This is species-rich, tall, tussocky vegetation. The dense, uneven sward of *Molinia caerulea* is patterned with clumps of *Carex nigra*, or, in some stands, *Juncus acutiflorus* and *J. conglomeratus*. It is scattered with forbs, such as *Caltha palustris*, *Valeriana dioica*, *Succisa pratensis* and *Filipendula ulmaria*, among which there are usually some upland species, including *Trollius europaeus*, *Crepis paludosa* and in some places *Primula farinosa*. There is little opportunity for a lush growth of bryophytes under the shade of the taller vascular species, but there is usually some *Calliergonella cuspidata*, its pointed shoots meshed together over the wet surface of the soil.

There are two sub-communities. The *Sanguisorba officinalis* sub-community M26a is defined by *Sanguisorba officinalis* and *Angelica sylvestris*, and also has *Galium palustre*, *Serratula tinctoria*, *Ctenidium molluscum*, *Campylopusium stellatum* and *Plagiochila asplenoides*. The more grassy *Festuca rubra* sub-community M26b has *Festuca rubra*, *Briza media*, *Holcus lanatus*, *Deschampsia cespitosa*, *Anthoxanthum odoratum*, *Lathyrus pratensis*, *Geum rivale* and *Juncus acutiflorus*.

#### DIFFERENTIATION FROM OTHER COMMUNITIES

*Molinia-Crepis* mire is most likely to be confused with the *Angelica* sub-community of *Molinia-Potentilla* mire M25c and the predominantly lowland *Molinia caerulea-Cirsium dissectum* fen-meadow M24. All of these forms of *Molinia* grassland can have a rich flora of herbs. *Molinia-Crepis* mire can be distinguished from *Molinia-Cirsium* fen-meadow because it has *Crepis paludosa*, *Trollius europaeus* or *Sanguisorba officinalis*, and lacks *Cirsium dissectum*. In comparison with *Molinia-Potentilla* mire, *Molinia-Crepis* mire has more *Valeriana dioica*, *S. officinalis*, *C. paludosa*, *Briza media*, *Carex pulicaris* and *C. hostiana*.

#### ECOLOGY

*Molinia-Crepis* mire is confined to peats or peaty soils that are enriched with base-rich water, usually over calcareous rocks, such as limestone. It occurs on flushed slopes or around open water, typically as small stands set in a matrix of other wet grasslands and mires. The peats are wet but not waterlogged except in winter. The pH of the substrate is generally between 5.5 and 7.0. This is a sub-montane type of vegetation and most stands are below 500 m.

#### DISTRIBUTION

This scarce community has been recorded only at a few sites in north Wales, the northern Pennines, the Lake District, the Southern Uplands, the Highlands and the eastern Scottish lowlands.

There is related vegetation in parts of Scandinavia and central Europe.

### ***Filipendula ulmaria-Angelica sylvestris* tall-herb fen (M27)**

#### DESCRIPTION

This is a tall, lush, herb-rich mire dominated by *Filipendula ulmaria*. In summer the dark-green sward is scattered with dense creamy patches of sweet-scented flowers - a colourful sight against the sombre greens and browns of other upland grasslands, heaths and mires.

The three sub-communities are defined by the species that grow with the meadowsweet. The *Valeriana officinalis-Rumex acetosa* sub-community M27a has more tall herbs than the others; characteristic species include *Angelica sylvestris*, *Valeriana officinalis*, *Caltha palustris* and *Lychnis flos-cuculi*, and there can be some northern or upland plants, such as *Crepis paludosa*, *Alchemilla glabra*, *Trollius europaeus* and *Cirsium heterophyllum*. The *Urtica dioica-Vicia cracca* sub-community M27b is a more lowland type, with weedy plants of disturbed eutrophic soils, including *Urtica dioica*, *Galium aparine* and *Cirsium arvense*. It could be regarded as transitional between tall-herb fen and coarse grassland, *Phragmites* fen and certain weedy vegetation types. The *Juncus effusus-Holcus lanatus* sub-community M27c resembles the *Juncus effusus* sub-community of *Juncus-Galium* rush-pasture M23b, and is characterised by *Juncus effusus*, *Holcus lanatus*, *Mentha aquatica* and *Lotus uliginosus*.

#### DIFFERENTIATION FROM OTHER COMMUNITIES

*Filipendula-Angelica* fen can be confused only with the other tall-herb mires and grasslands in which *Filipendula ulmaria* plays a part: *Juncus-Galium* rush-pasture M23, *Iris-Filipendula* mire M28 and *Filipendula-Arrhenatherum* tall-herb grassland MG2. In comparison with the first two communities, *Filipendula-Angelica* fen is dominated by *F. ulmaria*, rather than rushes or *Iris pseudacorus*. *Filipendula-Arrhenatherum* grassland has less *F. ulmaria* than *Filipendula-Angelica* fen, and has more grasses and woodland forbs, such as *Mercurialis perennis* and *Heracleum sphondylium*.

#### ECOLOGY

This is a mire of damp mesotrophic soils at low to moderate altitudes, extending up to about 400 m. It generally occurs in mosaics with other tall-herb mires and swamps, in glens and wet hollows, alongside slow-moving streams, at the edges of lochs, and on flushed slopes close to sea-level. These are all places where the water-table fluctuates widely over the year.

#### DISTRIBUTION

*Filipendula-Angelica* fen is widespread throughout Britain, especially in the lowlands. In the uplands it occurs in south-west England, Wales, the Lake District and Scotland. There are regional differences in the distributions of the sub-communities: the *Valeriana-Rumex* sub-community is the most common form in the north, the *Juncus-Holcus* sub-community is most common in the south and west, and the *Urtica-Vicia* sub-community is primarily a lowland type.

There are mires of this type in Ireland, and vegetation essentially similar to the herb-rich *Valeriana-Rumex* sub-community occurs in Germany, Holland, Belgium and France.

### ***Iris pseudacorus-Filipendula ulmaria* mire (M28)**

#### DESCRIPTION

This mire community comprises tall green swards of *Iris pseudacorus*, scattered with large untidy yellow flowers in summer, and interleaved with other tall herbs, such as *Filipendula ulmaria* and *Oenanthe crocata*. Other associated species include *Ranunculus acris*, *Cirsium palustre* and *Rumex acetosa*, and the grasses *Deschampsia cespitosa*, *Poa trivialis*, *Agrostis stolonifera* and *Holcus lanatus*. Under the vascular plants there is a thin layer of *Calliergonella cuspidata*, *Eurhynchium praelongum* and *Brachythecium rutabulum*. Stands near the coast are often entangled with seaweed, nylon rope, plastic bottles, driftwood and other debris washed up by high tides.

There are three sub-communities. The *Juncus* species sub-community M28a is moderately species-rich, and includes *Juncus effusus*, *J. acutiflorus*, *Ranunculus acris* and *Caltha palustris*. The *Urtica dioica-Galium aparine* sub-community M28b has more weedy species, such as *Urtica dioica*, *Galium aparine* and *Cirsium arvense*. The *Atriplex prostrata-Samolus valerandi* sub-community M28c is distinguished by maritime species, including *Atriplex prostrata*, *Samolus valerandi* and, in some places, *Triglochin maritima* and *Glaux maritima*. Grazed stands of *Iris-Filipendula* mire can be very grassy with few forbs, and can be impossible to assign to a sub-community.

#### DIFFERENTIATION FROM OTHER COMMUNITIES

This is the only type of vegetation dominated by *Iris pseudacorus*. *I. pseudacorus* can grow in *Juncus-Galium* rush-pasture M23, *Holcus-Juncus* grassland MG10, and *Filipendula-Angelica* tall-herb fen M27, but these communities are dominated by *Juncus* species, *Holcus lanatus* or *Filipendula ulmaria*.

#### ECOLOGY

*Iris-Filipendula* mire is floristically and ecologically related to *Juncus-Galium* rush-pasture and *Filipendula-Angelica* tall-herb fen. The dominant species vary between the different communities, but they all share the same associated flora of tall mesotrophic herbs. The three communities can form complex and interpenetrating mosaics, but the tall sword-like leaves of *Iris pseudacorus* stand out in well-defined patches clothing damp, more or less neutral soils at very low altitudes. The distribution and relative proportions of the different rush-pasture and fen types are determined by local variation in soil conditions, grazing and probably also cultivation; some stands of *Iris-Filipendula* mire are within or very close to old lazy-beds. *I. pseudacorus* can flourish only where the climate is mild and oceanic, and most stands of *Iris-Filipendula* mire are close to the sea, extending only a few kilometres inland and rarely occurring above 150 m.

#### DISTRIBUTION

*Iris-Filipendula* mire is common in coastal areas of the western Highlands and the Hebrides. It occurs much less commonly along the coasts of Shetland, Orkney, northern Scotland and Ayrshire. There are also outlying records in south-west England (not shown on the distribution map) and south-west Wales.

Fragmentary stands of similar vegetation occur locally in south-west Scandinavia.

### ***Hypericum elodes-Potamogeton polygonifolius* soakway (M29)**

#### DESCRIPTION

The hairy, silvery-grey shoots of *Hypericum elodes* and the shiny green leaves of *Potamogeton polygonifolius* grow here in loose drifts in shallow running water. *H. elodes* has clusters of bright yellow flowers which enliven the sward in summer. Surrounding the vascular plants is an open weft of mosses consisting mainly of *Sphagnum denticulatum*, *S. fallax* and *Calliergonella cuspidata*. Rising above this low mat of mosses are shoots of *Molinia caerulea*, *Carex viridula* ssp. *oedocarpa*, *C. panicea*, *Eriophorum angustifolium* and *Ranunculus flammula*. At their feet, often hard to see against the mosses, there may be delicate trailing shoots of *Anagallis tenella* and the dainty pale-green leaves of *Wahlenbergia hederacea*.

Some soakways lack *H. elodes* but otherwise have a flora similar to the *Hypericum-Potamogeton* community; most of these stands are beyond the geographical range of *H. elodes* but could perhaps be considered as forms of the community.

#### DIFFERENTIATION FROM OTHER COMMUNITIES

This distinctive community, with its characteristic dominant species, is hard to confuse with other upland vegetation types. Species-poor forms without *Hypericum elodes* may be confused with *Sphagnum denticulatum* bog pools M1, which have a similar array of bryophytes and can have much *Potamogeton polygonifolius*, *Menyanthes trifoliata* and *Juncus bulbosus*. *Hypericum-Potamogeton* soakways have more *Carex viridula*, *C. panicea*, *Ranunculus flammula* and *Calliergonella cuspidata*, whereas bog pools have a more continuous layer of *Sphagnum* and more *Narthecium ossifragum* and *Drosera* species.

#### ECOLOGY

*Hypericum-Potamogeton* soakways occur where water emerges from the ground and flows more or less permanently over the surface in runnels and seepages. Some stands are associated with springs or stream-edges and form isolated patches within a matrix of drier grasslands and heaths. Others occur within mosaics of different mire types or mark out the wettest places within valley bogs. The community also occurs in peaty pools within blanket bogs. A few stands are in situations that can become rather dry in summer. The soils are peats or peaty gleys, and the water is acid, with a pH between 4.0 and 5.5 (Rodwell 1991b). The community occurs at low to moderate altitudes.

#### DISTRIBUTION

*Hypericum-Potamogeton* soakways are distributed throughout the oceanic west of Britain, from south-west England as far north as the Inner Hebrides and mid-west Highlands. They are most common in Wales and south-west England. The community is also recorded in Dorset and Hampshire.

Similar vegetation occurs in Ireland and elsewhere in western Europe.

### ***Anthelia julacea-Sphagnum denticulatum* spring (M31)**

#### DESCRIPTION

These bryophyte-dominated springs form patches that stand out distinctly from the surrounding vegetation. The dark silvery-green tight mats and cushions of *Anthelia julacea* are interleaved with the twisted red-gold shoots of *Sphagnum denticulatum*, the diminutive dark-red stems of *Marsupella emarginata*, and the dark red-purple tufts of *Scapania undulata*. Rooted in this dense carpet of bryophytes are small vascular plants: *Viola palustris*, *Nardus stricta*, *Narthecium ossifragum*, *Saxifraga stellaris* and *Deschampsia cespitosa*.

#### DIFFERENTIATION FROM OTHER COMMUNITIES

This community has more *Anthelia julacea* than any other bryophyte springs. The dense mats of *A. julacea* can resemble the liverwort crusts of *Salix-Racomitrium* snow-beds U12, where the related *A. juratzkana* is common, but the snow-beds are generally drier, and have a more mixed mat of liverworts studded with *Salix herbacea* and montane mosses.

#### ECOLOGY

*Anthelia-Sphagnum* springs are virtually restricted to the montane zone above 600 m and are commonly associated with *Nardus-Carex* snow-beds U7. They can occur on slopes of any aspect. The habitat varies from level ground around large snow-beds in the corries of the north-west Highlands and on the Cairngorm plateaux, to steep banks and rocky slopes below cliffs.

The waters that feed the springs often run from melting snow and are very cold. The water flows more slowly than in the *Philonotis-Saxifraga* M32 or *Pohlia wahlenbergii* M33 springs (McVean and Ratcliffe 1962). Soils are fragmentary accumulations of debris trapped under the vegetation. The community occurs on a wide range of rock types, and the irrigating water is acid.

#### DISTRIBUTION

The community is common in the Scottish Highlands, and also occurs on some of the higher hills in south-west Scotland, the Lake District and north Wales.

There is similar vegetation in Norway and in the Faroes (Hobbs and Averis 1991a).

### ***Philonotis fontana-Saxifraga stellaris* spring (M32)**

#### DESCRIPTION

These small springs spangle the hillsides with deep rich colours. Bryophytes predominate, growing in deep spongy mats and patches. Any one of a number of species can prevail here: the most common are the apple-

green *Philonotis fontana*, the almost impossibly bright yellow-green *Dicranella palustris*, the red-gold *Sphagnum denticulatum*, and the red-purple *Scapania undulata*, but other possible dominants include the reddish *Calliergon sarmentosum*, the mid-green *Warnstorfia fluitans*, and the green, red or purple *Nardia compressa* and *Scapania uliginosa*. The bryophyte carpets are studded with small vascular species, especially sprawling plants of *Montia fontana* and *Chrysosplenium oppositifolium*, rosettes of *Saxifraga stellaris* with its loose clusters of white flowers, *Epilobium palustre* and in some places the scarcer *E. anagallidifolium* or *E. alsinifolium*. Isolated stands rarely cover more than a few square metres, and are sharply demarcated from the drier ground around them, but on high slopes and in corries they can coalesce to form a brightly-coloured network along the sides of springs and shallow rills.

There are two sub-communities. *Sphagnum denticulatum* is common in the *Sphagnum denticulatum* sub-community M32a, which is rather species-poor. In contrast, the *Montia fontana*-*Chrysosplenium oppositifolium* sub-community M32b takes in more varied, species-rich stands with a greater range of plants in the bryophyte cushions. Around the old copper mines in Snowdonia there are *Philonotis*-*Saxifraga* springs with a distinctive flora of species that can tolerate heavy metals, including *Armeria maritima*, *Cerastium arcticum* and *Minuartia verna*.

#### DIFFERENTIATION FROM OTHER COMMUNITIES

This vegetation can be confused with a few other types of spring or rill. The more montane *Pohlia wahlenbergii* spring M33 is dominated by the bright-green moss *Pohlia wahlenbergii* var. *glacialis*. The community's southern counterpart is the *Ranunculus*-*Montia* spring M35; this has *Ranunculus omiophyllus* and no montane species. *Palustriella commutata* or *Cratoneuron filicinum* dominate *Palustriella*-*Festuca* M37 and *Palustriella*-*Carex* M38 springs, but occur sparsely, if at all, in *Philonotis*-*Saxifraga* springs.

#### ECOLOGY

This community is confined to the immediate vicinity of springs and to the margins of small streams. It can be associated with almost any type of upland vegetation. In many places it forms mosaics with other springs, such as the *Anthelia*-*Sphagnum* M31 and *Pohlia wahlenbergii* types, especially on flat ground around late snow-beds. Downstream, these spring communities are generally replaced by *Carex*-dominated mires.

There are *Philonotis*-*Saxifraga* springs at all altitudes but they are scarce below 400 m (McVean and Ratcliffe 1962). They occur on a wide range of rock types but are rare on limestone, where *Philonotis fontana* is generally replaced by *P. calcarea*. The pH of the irrigating water can vary from less than 5.0 to more than 7.5 (A M Averis unpublished): this probably accounts for the great diversity of the flora. Soils are usually fragmentary - silt and humus trapped among stones - but the community can occur on flushed peats or gleys.

#### DISTRIBUTION

*Philonotis*-*Saxifraga* springs are associated with a cool, wet climate. The distribution of the community shows a noticeable northern bias, although it is widespread in the uplands from mid Wales northwards. Further south, springs tend to be dominated by more thermophilous species, and the *Philonotis*-*Saxifraga* community is replaced by the *Ranunculus*-*Montia* spring. In general, the montane element in the flora is most strongly developed at higher altitudes and northerly latitudes.

Almost identical vegetation has been recorded in Ireland, Scandinavia, Greenland, Iceland, the Faroes and central Europe.

### ***Pohlia wahlenbergii* var. *glacialis* spring (M33)**

#### DESCRIPTION

These are attractive springs in which the pale-green plants of *Pohlia wahlenbergii* var. *glacialis*, covered with shining drops of water, stand out clearly from the surrounding vegetation in patches of almost luminous green. The colour of the stands is so distinctive that they are noticeable from a great distance. The springs are composed of the dense, glaucous shoots of *P. wahlenbergii* var. *glacialis*, in some places with a little *Philonotis fontana* or *Scapania undulata*. The deep-green *Pohlia ludwigii* may also be common, especially on slightly drier ground around the edges of springs. The bryophyte mats are speckled with a few small montane vascular plants, such as *Saxifraga stellaris*, *Deschampsia cespitosa* ssp. *alpina* and *Cerastium cerastoides*. There is not much variation in the flora or the habitat of this community throughout its British range.

#### DIFFERENTIATION FROM OTHER COMMUNITIES

This community is easily distinguished from other types of springhead vegetation because it is dominated by *Pohlia wahlenbergii* var. *glacialis*.

#### ECOLOGY

In Britain, *Pohlia wahlenbergii* springs are associated with late snow-beds at high altitudes in the Scottish Highlands; most stands are at altitudes above 900 m. They are generally on the steep upper slopes of corries or in gullies, but can also occur on flatter ground in mosaics with other springs, such as *Philonotis-Saxifraga* springs M32. Where the community is associated with very late snow-beds, it can form the only continuous vegetation, being surrounded by silty unstable banks with a sparse carpet of *Pohlia ludwigii*. The substrate is usually base-poor and the soil is a thin, poorly-structured accumulation of silt and humus. The water which feeds these springs is very cold - always below 4°C (McVean and Ratcliffe 1962).

#### DISTRIBUTION

The main centre of distribution is the central and eastern Highlands - the areas with the most late-lying snow-beds. The community is also represented, though less commonly, throughout the high mountain ranges as far north as Ben More Assynt in Sutherland and as far west as Ben Lui and Ben Nevis. It appears to be absent from the Hebrides. *Pohlia glacialis* var. *wahlenbergii* grows very locally on wet gravelly soils at high altitudes in the hills of the Lake District and north Wales, but the community has not been recorded there.

There is spring vegetation similar to this community in Norway and the Faroes, where it is usually but not exclusively associated with late-lying snow. In the milder climate of Britain, snow-beds are evidently the only places where the microclimate is cold enough for the community to develop. *Pohlia*-dominated springs form one of the important links between British vegetation and that of the colder northern mountain regions in other parts of Europe.

### ***Carex viridula* ssp. *oedocarpa*-*Koenigia islandica* flush (M34)**

#### DESCRIPTION

This is an open flush community containing the annual *Koenigia islandica*. There is a thin, sparse sward of *Carex viridula* ssp. *oedocarpa* and *C. panicea*, usually with scattered plants of *Deschampsia cespitosa*, *Saxifraga stellaris*, *Juncus triglumis*, and in some places other montane calcicoles, such as *J. biglumis*, *Persicaria vivipara* and *Luzula spicata*. Among these vascular plants are tufts and wefts of bryophytes, most commonly *Blindia acuta*, *Hylocomium splendens* and *Marsipella emarginata*. The tiny plants of *Koenigia* are inconspicuous except in autumn, when the leaves and stems turn a rich bright red.

#### DIFFERENTIATION FROM OTHER COMMUNITIES

In the summer months the presence of *Koenigia* distinguishes this community, although it grows just as commonly on gravelly fell-fields. During the winter, when *Koenigia* cannot be seen, the vegetation could be assigned to the *Carex-Saxifraga* mire M11.

#### ECOLOGY

*Carex-Koenigia* flushes occur on basalt gravel that is irrigated by cool acid or neutral water. Most stands are above 500 m in the montane zone. They occur among grasslands, sedge mires or summit heaths, and on rocky detritus below cliffs. In some places the community is associated with *Philonotis-Saxifraga* springs M32. *Koenigia* is sensitive to competition and tolerates open, unstable soils that are suitable for few other species.

#### DISTRIBUTION

This community has been found only on basalt in the Trotternish region of Skye and the Ardmeanach peninsula of Mull (Birks 1973; Averis and Averis 1997b, 1999b). *Koenigia* seems to require basic rocks and grows particularly well on basalt.

Similar vegetation occurs in Norway, northern Sweden, Iceland, the Faroes and Spitzbergen.

### ***Ranunculus omiophyllus*-*Montia fontana* rill (M35)**

#### DESCRIPTION

This community comprises open or close-crowded patches of vegetation emerging from shallow running water or on irrigated wet mud. *Ranunculus omiophyllus* or *Montia fontana* are generally the most common species, and in summer the rounded crenate leaves and white fragile flowers of *R. omiophyllus* mark out the stands amid the surrounding heaths and grasslands. *Potamogeton polygonifolius* is common, growing with its shiny oval leaves

held almost vertically where the sward of other plants is very dense, and there can be a few patches of *Sphagnum denticulatum*.

#### DIFFERENTIATION FROM OTHER COMMUNITIES

The *Ranunculus-Montia* rill community resembles the *Philonotis-Saxifraga* spring M32, but lacks montane plants, such as *Saxifraga stellaris*, *Epilobium alsinifolium*, *E. anagallidifolium* and *Scapania uliginosa*. In their place it has *Ranunculus omiophyllus* and other lowland species, such as *Callitriche stagnalis* and *Poa annua*. *Hypericum-Potamogeton* soakways M29 can look rather similar, but have *Hypericum elodes* and little or no *R. omiophyllus* or *Montia fontana*.

#### ECOLOGY

*Ranunculus-Montia* rills occur in running water in springs, shallow streams and channels with peaty or muddy substrates. They usually occur as small, well-defined stands among mires, heaths and grasslands. The pH of the soils ranges from 4.5 to 6.5 (Rodwell 1991b), and the underlying rocks are usually acid igneous or sedimentary types, such as granite, slate and shale. This is a community of low to moderate altitudes and has not been recorded above 450 m (Rodwell 1991b).

#### DISTRIBUTION

This community replaces the *Philonotis-Saxifraga* spring in warmer oceanic environments, and is most common in the uplands of south-west England, Wales and the Pennines. It had not been described from Britain prior to the publication of the NVC, and for this reason is probably under-recorded.

Similar vegetation occurs in Ireland and in the mountains of Spain and Portugal.

### ***Palustriella commutata-Festuca rubra* spring (M37)**

#### DESCRIPTION

The swelling golden-brown cushions or mounds of the moss *Palustriella commutata* grow here in springheads where water issues from the ground, or hang in dripping curtains over wet calcareous rock faces. In some places *Cratoneuron filicinum* replaces *P. commutata*, and across the Breadalbanes the rare *P. decipiens* can grow here too. The bryophyte mats are usually species-poor, with *P. commutata* and *C. filicinum* accompanied by little other than *Bryum pseudotriquetrum*, *Philonotis fontana*, *Aneura pinguis* and *Scapania undulata*. There is a light sprinkling of vascular plants, including sparse clusters of *Festuca rubra* and *Agrostis canina*, and in some places rich-green clumps of *Carex viridula* ssp. *oedocarpa* and glaucous tufts of *C. panicea* and *C. flacca*. In many stands the bryophyte mats are studded with yellow-green stars of *Pinguicula vulgaris*, and there may also be the fat grey shoots and clustered golden flowers of *Saxifraga aizoides* or the neat rosettes and white delicate flowers of *S. hypnoides*. Other common species include *Filipendula ulmaria*, *Trollius europaeus* and *Cardamine pratensis*. Some *Palustriella-Festuca* springs contain deposits of calcium carbonate (known as tufa) around the plants, giving a whitish appearance and a crunchy, almost gravelly feel underfoot.

#### DIFFERENTIATION FROM OTHER COMMUNITIES

*Palustriella-Festuca* springs are usually very distinctive. They can resemble the more exclusively montane *Palustriella-Carex* spring M38, but contain fewer montane species and have a more open and less diverse layer of vascular plants. In some cases it can be difficult to draw a dividing line between this community and *Carex-Pinguicula* M10 and *Carex-Saxifraga* M11 mires. In general, the short-sedge flushes have more sedges, such as *Carex viridula* ssp. *oedocarpa*, *C. pulicaris* and *C. panicea*, and more bryophytes and calcicolous forb species. Stands with a continuous carpet of bryophytes dominated by either *Palustriella commutata* or *Cratoneuron filicinum* over at least a square metre or so of ground, and where sedges and other small plants are sparse or absent, are *Palustriella-Festuca* springs rather than sedge-mires.

#### ECOLOGY

The community typically occurs as small stands in springs, on wet rocks and on flushed banks where the irrigating water is base-rich. It is confined to calcareous rocks. The underlying soil is usually a humus-rich silty mud. The altitudinal range is extremely wide, and the community occurs in essentially the same form in low-altitude woodlands as well as in montane grasslands. However, it is rarer at high altitudes where soils are more leached.

#### DISTRIBUTION

*Palustriella-Festuca* springs occur throughout the British uplands from south Wales northwards, but are restricted to areas with highly calcareous rocks. They are most common on the Carboniferous limestone of northern England (including the Orton and Craven Fells) and on the Dalradian rocks of the Breadalbane region, but there

are also some fine stands on the Moine rocks of the northern Highlands, the Durness limestone on Skye and in the north-west Highlands, the calcareous igneous and sedimentary rocks of the Lake District and north Wales, and the Silurian shales of the Southern Uplands.

There are similar springs in the Norwegian and Swedish mountains.

### ***Palustriella commutata-Carex nigra* spring (M38)**

#### DESCRIPTION

*Palustriella-Carex* springs consist of golden-brown mats of *Palustriella commutata*. In comparison to *Palustriella-Festuca* springs M37, they have a thicker sward of vascular plants over a more diverse carpet of bryophytes. *Bryum pseudotriquetrum*, *Philonotis fontana*, *P. calcarea* and *Aneura pinguis* are more conspicuous among the *P. commutata*, and there is a rich spread of small sedges and other vascular plants, including *Carex nigra*, *C. panicea*, *C. viridula* ssp. *oedocarpa*, *Selaginella selaginoides*, *Persicaria vivipara*, *Juncus triglumis* and *Sagina nodosa*. In some stands, *Cratoneuron filicinum* takes the place of *P. commutata*.

#### DIFFERENTIATION FROM OTHER COMMUNITIES

These springs have more montane species and a more continuous sward of vascular plants than the *Palustriella-Festuca* community. They can be hard to separate from examples of *Carex-Pinguicula* M10 or *Carex-Saxifraga* M11 flushes with much *Palustriella commutata*, but they have a deeper and more continuous bryophyte layer dominated by *P. commutata* or *Cratoneuron filicinum*, and the vascular sward is usually sparser.

#### ECOLOGY

This is a montane community, occurring mainly at altitudes over 600 m. It is invariably associated with calcareous rocks where the emerging water is highly base-rich. The soils are saturated stagnogleys, commonly with a surface layer of peat and in places crunchy with precipitated calcium carbonate (Rodwell 1991b). Individual stands are generally small, corresponding to the area of fast-flowing water, but there can be many patches scattered across large areas of upland: for example, networks of springs along the side of a valley. The springs can grade into *Carex-Pinguicula* mire or *Festuca-Agrostis-Thymus* grassland CG10 with increasing distance from the springhead. Other stands are sharply delimited from the surrounding vegetation.

#### DISTRIBUTION

*Palustriella-Carex* mire is a scarce community and has been recorded mainly around the Carboniferous limestone of Upper Teesdale and on the Dalradian rocks of the Breadalbane region of the central Highlands. There are outlying stands in the Pentland Hills, the Southern Uplands and in the Orton area of Cumbria.

Similar vegetation occurs in northern Scandinavia and in montane areas of central Europe.

## 1.4. Heath communities (H4, H8-10, H12-22)

### *Ulex gallii*-*Agrostis curtisii* heath (H4)

#### DESCRIPTION

This is a dense mixed heathland, which becomes a splendid blaze of purple and gold when the dwarf shrubs are in flower in late summer. *Calluna vulgaris*, *Ulex gallii*, *Molinia caerulea*, *Erica tetralix*, *E. cinerea*, and in some stands *Vaccinium myrtillus*, grow in a thick sward together with the delicate flowers and narrow grey-green leaves of the grass *Agrostis curtisii*. In some examples the dwarf shrubs are bound together by the red sinuous shoots of *Cuscuta epithymum*.

There are four sub-communities. The *Agrostis curtisii*-*Erica cinerea* sub-community H4a stands out from the others because it has hardly any *E. tetralix*. The *Festuca ovina* sub-community H4b is grassy, with species such as *Festuca ovina*, *Danthonia decumbens* and *Agrostis canina* either growing in a fine-scale mosaic with the dwarf shrubs or forming more intimate mixtures; *E. cinerea* and *E. tetralix* occur only in small quantity. *Molinia* is common in some stands of the *Agrostis*-*Erica* and *Festuca* sub-communities but very sparse in others; it is more consistently common in the other two sub-communities. The *Erica tetralix* sub-community H4c is a short, rather sparse and open damp heath, in which the vegetation is commonly broken by patches of bare peat and humus; it is given a greyish tinge by *E. tetralix* and *Carex panicea*, which in some places make up the bulk of the sward. The *Trichophorum cespitosum* sub-community H4d is also a damp heath, typically with *Trichophorum cespitosum*, *Molinia* and *E. tetralix*.

#### DIFFERENTIATION FROM OTHER COMMUNITIES

This community looks very similar to the strictly lowland *Ulex minor*-*Agrostis curtisii* heath H3, but the characteristic gorse is *Ulex gallii* rather than *U. minor*. Another similar-looking vegetation type is *Calluna-Ulex gallii* heath H8, which differs from *Ulex gallii*-*Agrostis* heath in having little or no *Agrostis curtisii*, *Molinia* and *Erica tetralix*. The damper forms of *Ulex gallii*-*Agrostis* heath (mainly the *Erica* and *Trichophorum* sub-communities) can resemble *Trichophorum-Erica* wet heath M15 and *Erica-Sphagnum compactum* wet heath M16, but have much *A. curtisii* and *U. gallii*, both of which are rare in the wet heath communities. In Ireland and Wales there are forms of damp heath consisting mainly of *Calluna*, *U. gallii*, *Molinia*, *E. tetralix* and *E. cinerea* (Hobbs and Averis 1991b; Derek Ratcliffe pers. comm.; Averis 2001a); these closely resemble *Ulex gallii*-*Agrostis* heath but lack *A. curtisii*.

The NVC treatment of *Ulex gallii*-*Agrostis* heath unites various forms of heathland into a single NVC community on the basis of the combined presence of the south-western species *A. curtisii* and *U. gallii*. The community is described as a damp rather than a dry heath, but it includes some vegetation with sufficiently little *Molinia*, *E. tetralix* or *Trichophorum* to be better described as dry heath. Much of the vegetation assigned to the *Agrostis-Erica* and *Festuca* sub-communities might be better understood as south-western '*Agrostis curtisii*-*Ulex gallii*' forms of *Calluna-Ulex gallii* H8, *Calluna-Erica* H10 or *Calluna-Vaccinium* H12 dry heaths. Conversely, the *Erica* and *Trichophorum* sub-communities could be regarded as south-western '*Agrostis curtisii*-*Ulex gallii*' forms of *Trichophorum-Erica* or *Erica-Sphagnum compactum* wet heaths.

#### ECOLOGY

*Ulex gallii*-*Agrostis* heath is described as a community of moist gleyed soils or moist podsols over acid rocks, although certain details in the floristic table contained in the NVC suggest that some of the vegetation is actually on drier soils (see above). It occurs from sea-level to over 500 m in the uplands of south-west England. Most of the stands at lower altitudes are on level moorland. The higher examples are usually on steeper slopes because in the wet upland climate the gentler slopes and flat plateaux are blanketed with peat.

#### DISTRIBUTION

This type of heathland is confined to south-west England and south Wales, where it is recorded in both upland and lowland areas. In the uplands it is well represented on Dartmoor, Exmoor and the Penwith moorlands, and sparingly on moorland in the valleys of south Wales. The grassy swards with a scattering of shrubs on Bodmin Moor are a form of this community impoverished by grazing. Damp heaths with a similar flora to *Ulex gallii*-*Agrostis* heath, but lying beyond the range of *Agrostis curtisii*, have been recorded in mid and north Wales (see above).

Heathland similar to this community occurs in the oceanic regions of western France, Portugal and Spain.

## ***Calluna vulgaris-Ulex gallii* heath (H8)**

### DESCRIPTION

These are mixed heaths of *Calluna vulgaris*, *Ulex gallii* and *Erica cinerea*, all of which flower in splendid tones of purple and gold in late summer.

There are five sub-communities, of which only three are likely to occur in the uplands. The Species-poor sub-community H8a has a dense canopy of *Calluna*, *U. gallii* and *E. cinerea* which few other plants are able to penetrate, although in some stands there can be much *Agrostis capillaris* and mosses such as *Hypnum cupressiforme*, *H. jutlandicum*, *Dicranum scoparium* and *Campylopus flexuosus*. In the grassy *Danthonia decumbens* sub-community H8b the dwarf shrubs are set in a matrix of acid grassland species, such as *Danthonia decumbens*, *Anthoxanthum odoratum*, *Festuca rubra*, *Agrostis canina*, *A. capillaris* and *Potentilla erecta*; in some stands the shrubs are grazed into tight round islands within a sea of grasses, and are hard to see from a distance when they are not in flower. The *Sanguisorba minor* sub-community H8c is a lowland heath of base-rich soils with species including *Sanguisorba minor*, *Helianthemum nummularium*, *Stachys officinalis* and *Galium verum*. The *Scilla verna* sub-community H8d is a coastal heath with *Scilla verna*, *Thymus polytrichus* and *Plantago maritima*. The *Vaccinium myrtillus* sub-community H8e occurs on acid soils in the uplands, and has *Deschampsia flexuosa*, *Nardus stricta*, *Rhytidiadelphus loreus* and *Pleurozium schreberi* under a thick prickly canopy of dwarf shrubs containing *V. myrtillus* in addition to *Calluna*, *U. gallii* and *E. cinerea*.

There are also species-poor heaths with much *U. gallii* but no *Calluna* or *E. cinerea*. The *U. gallii* grows either in dense swards or in a matrix of grasses. These heaths are not represented in the NVC, but clearly have a close affinity with *Calluna-Ulex gallii* heath. In Ireland and Wales there are damp heaths of *Calluna*, *U. gallii*, *Molinia*, *Erica tetralix* and *E. cinerea* (Hobbs and Averis 1991b; Derek Ratcliffe pers. comm.; Averis 2001a), which are also not described in the NVC. This vegetation might be regarded as a wet heath counterpart of *Calluna-Ulex gallii* heath or as being closely allied to *Ulex gallii-Agrostis* heath H4.

### DIFFERENTIATION FROM OTHER COMMUNITIES

*Calluna-Ulex gallii* heath is one of the few heathland types in which *Ulex gallii* is either dominant or co-dominant with other dwarf shrubs. Another such heath is *Ulex gallii-Agrostis* heath. This is distinguished by *Agrostis curtisii*, which is rare in *Calluna-Ulex gallii* heath and occurs only in stands in south-west England and south Wales. *U. gallii* also occurs in the strictly lowland *Erica vagans-Schoenus nigricans* H5 and *Erica vagans-Ulex europaeus* H6 heaths, but these contain the rare *Erica vagans* and are restricted to Cornwall. The undescribed damp heath recorded from Ireland and Wales differs from *Calluna-Ulex gallii* heath in that both *Molinia* and *E. tetralix* are common in the sward.

### ECOLOGY

*Calluna-Ulex gallii* heath occurs on free-draining soils which range from acid to mildly basic. The soils are derived from a wide variety of parent rocks, including sandstone and igneous and metamorphic rocks. Where the soils are derived from calcareous drift the heath can be moderately species-rich, and the *Sanguisorba* sub-community is characteristic. Where the soils are leached acid sand or peat the community is usually rather species-poor.

*Calluna-Ulex gallii* heath occurs in warm oceanic parts of the lowlands, including coastal cliffs and slopes, but also penetrates into the uplands. Most stands are below 350 m, but it occurs above 400 m on sheltered slopes. The community typically forms patches where steep slopes with mineral soils break through blanketing peat, and along the steep sides of gullies and stream valleys. In some places there are broad bands of it around the lower hill slopes; there are good examples of this in the Carneddau in north Wales, and also in the Mourne Mountains in eastern Ireland.

### DISTRIBUTION

This form of dry heath is most common in Wales, but also occurs in south-west England, East Anglia, Lincolnshire, the south Pennines, the Isle of Man, Cumbria and the Scottish side of the Solway Firth.

There are floristically similar heaths in Ireland, for example in Connemara (Horsfield *et al.* 1991) and in Northern Ireland (Hobbs and Averis 1991b). Outside Britain and Ireland heaths of this type are known only from the western seaboard of France, Spain and Portugal.

## ***Calluna vulgaris-Deschampsia flexuosa* heath (H9)**

### DESCRIPTION

Stands of *Calluna-Deschampsia* heath typically consist of a dark even-aged monoculture of *Calluna vulgaris* growing through the crusted surface of dried-out humus or peat. The sward is usually spiked with a little *Deschampsia flexuosa* with its silky panicles of flowers overtopping the heather in summer, and there is generally a green speckling of the moss *Pohlia nutans* over the ground.

The vegetation beneath the heather varies according to how recently the heath has been burnt. The five sub-communities described in the NVC encompass this variation. The *Hypnum cupressiforme* sub-community H9a takes in degenerate stands with an open canopy of old heather plants. Much of the ground is covered with a thick yellow-green weft of *Hypnum cupressiforme* s.l. (probably all *H. jutlandicum*), and there can be numerous clumps and cushions of *Dicranum scoparium*. *Pteridium aquilinum* grows in some stands. The *Vaccinium myrtillus-Cladonia* species sub-community H9b occurs in the early stages of recovery from fire when the heather is short and there is much bare peat. *Vaccinium myrtillus* recovers more quickly from fire than *Calluna* and can thicken up in the canopy. *Empetrum nigrum* or *V. vitis-idaea* commonly occur in small quantity, and over the soil there is a mixed and in some places dense mat of bryophytes including *Campylopus flexuosus* and *Gymnocolea inflata*, and a few encrusting lichens, such as *Cladonia chlorophaea*, *C. squamosa* and *C. diversa*. These persist until the heather canopy closes or until the heath is burnt again. The Species-poor sub-community H9c occurs when heather is in the building phase and is usually completely dominant. There can be a meagre scattering of *Deschampsia flexuosa*, *Vaccinium myrtillus* and the mosses *Pohlia nutans* and *Campylopus flexuosus*. The *Galium saxatile* sub-community H9d has a greener sward, with more forbs and grasses, generally because the heather has been suppressed by grazing. The most common species are *Potentilla erecta*, *Galium saxatile*, *Festuca rubra* and *Rumex acetosella*. The *Molinia caerulea* sub-community H9e has little to distinguish it except scattered tufts of *Molinia*.

### DIFFERENTIATION FROM OTHER COMMUNITIES

Other forms of dry heath are rarely as totally dominated by *Calluna* as is *Calluna-Deschampsia* heath. The most similar community is *Calluna-Vaccinium* heath H12, which generally has a more mixed canopy of dwarf shrubs, including *Vaccinium myrtillus*, and a more continuous underlayer of large pleurocarpous mosses, such as *Hylocomium splendens*, *Pleurozium schreberi* and *Rhytidiadelphus loreus*. Conversely, the small moss *Pohlia nutans* is commoner in *Calluna-Deschampsia* heath. Stands of the *Molinia* sub-community of *Calluna-Deschampsia* heath may superficially resemble *Trichophorum-Erica* wet heath M15 and *Erica-Sphagnum compactum* wet heath M16, but lack *Erica tetralix*, *Trichophorum cespitosum*, *Potentilla erecta* and *Sphagnum* species. The lowland *Calluna vulgaris-Festuca ovina* heath H1 can resemble *Calluna-Deschampsia* heath but has little or no *Deschampsia flexuosa*. Where *Vaccinium myrtillus*, *V. vitis-idaea* and *Empetrum nigrum* become temporarily common in stands of *Calluna-Deschampsia* heath as a result of burning and grazing, the community can be separated from *Vaccinium-Deschampsia* heath H18 by the scarcity of *Hypnum jutlandicum*, *Hylocomium splendens*, *Pleurozium schreberi*, *Dicranum scoparium* and other large mosses.

### ECOLOGY

This is a heath of acid podsolised mineral soils and sandy soils in the lowlands and upland fringes, occurring from low altitudes to almost 600 m. In the North York Moors, the Pennines and southern Scotland it is also common on dried-out peat, replacing more natural bog vegetation. The community clothes slopes and rolling moorland, and is common around the moorland edge where its lower limit coincides with the upper edge of enclosed grassland. At its upper limit it usually peters out into blanket mire in the cooler and wetter climate of the higher plateaux.

### DISTRIBUTION

*Calluna-Deschampsia* heath is most common on grouse moors in the southern Pennines northwards to lower Wharfedale, and on the North York Moors. It is extensive on the eastern dip slope of the Pennines as far north as the Tyne Gap. It also occurs in parts of eastern Scotland, on the Cheviot (not shown on the distribution map), on the Clwydian range in north Wales, on the Shropshire hills, and in the lowlands of Lancashire, Cheshire and the English Midlands.

There is related vegetation elsewhere in western Europe, especially where there is some atmospheric pollution.

## ***Calluna vulgaris-Erica cinerea* heath (H10)**

## DESCRIPTION

These are dry heaths with a low, dark-coloured canopy of *Calluna vulgaris* and *Erica cinerea*. The dwarf shrubs are typically overtopped by the long, deep-green leaves and drooping brownish flowers of *Carex binervis*; *Potentilla erecta* and *Galium saxatile* scramble over the ground below the shrubs. There is usually a thick carpet of mosses, such as *Pleurozium schreberi*, *Rhytidiadelphus loreus*, *Hylocomium splendens* and *Hypnum jutlandicum*. *E. cinerea* begins to flower before the *Calluna*, enlivening the heaths with patches of rosy-pink before the purple heather blossoms open in late summer. When both shrubs are in flower the effect is stunning, and whole hillsides can be transformed into richly-coloured, almost glowing, fragrant spreads of flowers.

There are four sub-communities, all well-defined and generally easy to recognise. The Typical sub-community H10a has no special distinguishing species, and usually has a thick, continuous canopy of dwarf shrubs. The *Racomitrium lanuginosum* sub-community H10b occurs mainly at higher elevations, and has a shorter, sparser and more open canopy that reveals the thick silvery mats of *Racomitrium lanuginosum* clothing the ground beneath the dwarf shrubs. There can be a speckling of lichens, such as *Cladonia portentosa* and *C. uncialis* ssp. *biuncialis*, and there may be scattered plants of *Trichophorum cespitosum*, *Huperzia selago* or *Antennaria dioica*. The *Festuca ovina*-*Anthoxanthum odoratum* sub-community H10c is a paler-coloured, grassier assemblage of species in which the dwarf shrubs are interleaved with *Festuca ovina*, *F. rubra*, *Anthoxanthum odoratum* and *Agrostis capillaris*. The *Thymus polytrichus*-*Carex pulicaris* sub-community H10d is species-rich, usually with a profusion of *Thymus polytrichus* and small herbs under a short and open sward of dwarf shrubs. Characteristic species include *Lotus corniculatus*, *Linum catharticum*, *Prunella vulgaris*, *Viola riviniana*, *Primula vulgaris* and *Pilosella officinarum*.

The growth of *E. cinerea* appears to be particularly favoured by a mild, oceanic climate, and in the far western Highlands and on Skye, and more commonly in Ireland, there are *Calluna-Erica* heaths with more *E. cinerea* than *Calluna* (e.g. Hobbs and Averis 1991b). In the northern Highlands and on Orkney and Shetland there are stands of *Calluna-Erica* heath in which the ground is blanketed with white *Cladonia* lichens; some of these are at low altitudes close to the coast (e.g. Coppins and Coppins 1999).

## DIFFERENTIATION FROM OTHER COMMUNITIES

This is a dry *Calluna* heath, distinguished from the damper *Calluna-Vaccinium-Sphagnum* H21 and *Vaccinium-Rubus* H22 heaths by the scarcity of Sphagna, and from *Trichophorum-Erica* M15 and *Erica-Sphagnum compactum* M16 wet heaths by the scarcity of *Erica tetralix*, *Molinia caerulea*, *Trichophorum cespitosum* and Sphagna. In contrast to *Calluna-Deschampsia* heath H9 and *Calluna-Vaccinium* heath H12, this community contains much *Erica cinerea* and little or no *Vaccinium myrtillus*. *Ulex gallii*-*Agrostis* heath H4 and *Calluna-Ulex gallii* heath H8 contain both *Calluna* and *E. cinerea*, but also have much *Ulex gallii*, which is rare in *Calluna-Erica* heath.

The *Racomitrium* sub-community may be confused with *Calluna-Racomitrium* heath H14, the *Racomitrium* sub-community of *Nardus-Galium* grassland U5e, or the *Cladonia* sub-community of *Trichophorum-Erica* wet heath M15c, all of which share *Calluna*, *E. cinerea*, *Racomitrium lanuginosum* and *Potentilla erecta*. However, the heather in *Calluna-Racomitrium* heath is prostrate or severely dwarfed by the wind, and the vegetation usually contains montane species, such as *Festuca vivipara*, *Diphasiastrum alpinum*, *Carex bigelowii*, *Ochrolechia frigida* and *Cetraria islandica*. The *Racomitrium* sub-community of *Nardus-Galium* grassland has more *Nardus stricta*, *Trichophorum* and *Galium saxatile* than similar forms of *Calluna-Erica* heath. The *Cladonia* sub-community of *Trichophorum-Erica* wet heath has more *E. tetralix*, *Molinia* and *Trichophorum*.

The herb-rich *Thymus-Carex* sub-community could be confused with heathy stands of the *Calluna-Primula* sub-community of *Luzula-Geum* tall-herb vegetation U17d, but this has more *Luzula sylvatica*, *Angelica sylvestris*, *Geum rivale*, *Sedum rosea* and *Filipendula ulmaria*. Some forms of the *Thymus-Carex* sub-community resemble the coastal *Calluna vulgaris-Scilla verna* heath H7, but they generally lack maritime species, such as *Scilla verna* and *Plantago maritima*, as well as having less *Holcus lanatus*, *Plantago lanceolata* and *Hypochaeris radicata*.

## ECOLOGY

This is a heath of well-drained mineral soils, and is common on steep, stony slopes. Many patches of *Calluna-Erica* heath stand out clearly as patches of dark vegetation on steeper ground, contrasting with the paler tones of the surrounding bogs and wet heaths or the varied greens of upland grasslands. The soils are generally acid, although those with the herb-rich *Thymus-Carex* sub-community are evidently more basic; this sub-community is especially common on the basalts of Skye and Mull. *Calluna-Erica* heath rarely occurs

above about 400 m except in the mild, oceanic climate of the western Highlands and the Hebrides where it can ascend to almost 800 m. Further north and east it is usually associated with warm south-facing or west-facing slopes at low altitudes.

#### DISTRIBUTION

*Calluna-Erica* heath is widespread in western and northern Britain from Devon to Shetland, and is most common in the western Highlands and the Hebrides.

There is similar vegetation in Ireland (Hobbs and Averis 1991b; Horsfield *et al.* 1991). Heaths of this type also occur rather locally on the Faroes (Hobbs and Averis 1991a) and in western Norway.

### ***Calluna vulgaris-Vaccinium myrtillus* heath (H12)**

#### DESCRIPTION

*Calluna-Vaccinium* heaths are usually extensive and visually uniform, typically covering whole landscapes with a vast, unbroken, red-brown sward. When the heather comes into flower in the late summer, the dull dark moorlands become a blaze of vivid purple. The vegetation consists of a springy, deep canopy of *Calluna vulgaris*, entwined with the bright-green leafy shoots of *Vaccinium myrtillus*. There can also be much *Empetrum nigrum* and *V. vitis-idaea*. After a fire, when the heather is recovering, *V. myrtillus* may be temporarily dominant. Other vascular plants are usually inconspicuous below the canopy of dwarf shrubs, but the fine, dark-green leaves of *Deschampsia flexuosa* can be seen above the heather. Most stands of *Calluna-Vaccinium* heath have a rich golden-red underlay of large pleurocarpous mosses, including *Hylocomium splendens*, *Pleurozium schreberi*, *Rhytidiadelphus loreus* and *Hypnum jutlandicum*.

There are three sub-communities; these are rather less distinct than the sub-communities of *Calluna-Erica* heath H10 but represent similar ecological gradients. The *Calluna vulgaris* sub-community H12a may be regarded as the typical form of dry heather moor, with no distinguishing species other than those that define the community as a whole. The *Vaccinium vitis-idaea-Cladonia portentosa* sub-community H12b is characteristic of higher altitudes; as well as more *V. vitis-idaea*, it also has more *Empetrum nigrum*, and usually a few lichens, such as *Cladonia portentosa* and *C. uncialis* ssp. *biuncialis*. The *Galium saxatile-Festuca ovina* sub-community H12c is a more heavily grazed and grassy form of heath, with *Potentilla erecta*, *Galium saxatile*, *Festuca ovina* and *Nardus stricta*. Stands tend to be less mossy than the other sub-communities, and the canopy is paler, more variegated and less continuous, with green spreads of grassland showing between the heather bushes.

In the eastern Highlands, the Cairngorm foothills, the lower hills north of Ballater and Orkney, there are *Calluna-Vaccinium* heaths in which the ground under the dwarf shrubs is white with bushy lichens, including *Cladonia arbuscula*, *C. portentosa* and *C. uncialis* ssp. *biuncialis*. These have some similarities to the *Vaccinium-Cladonia* sub-community, but do not appear to be represented in the NVC.

#### DIFFERENTIATION FROM OTHER COMMUNITIES

*Calluna-Vaccinium* heath may be confused with any of the wet, damp or dry heaths in which *Calluna vulgaris* is the dominant species.

The general rarity of *Erica tetralix*, *Trichophorum cespitosum*, *Molinia caerulea* and *Sphagnum* species distinguishes the community from *Trichophorum-Erica* M15 and *Erica-Sphagnum compactum* M16 wet heaths. *Sphagnum capillifolium* is typically rare or absent, in contrast to *Calluna-Vaccinium-Sphagnum* damp heath H21. *Vaccinium-Rubus* damp heath H22 usually contains *S. capillifolium*, and also northern or montane species, such as *Empetrum nigrum* ssp. *hermaphroditum*, *Carex bigelowii*, *Vaccinium uliginosum*, *Rubus chamaemorus* and *Cornus suecica*.

*Calluna-Vaccinium* heath differs from *Calluna-Arctostaphylos uva-ursi* heath H16 in the scarcity of *Arctostaphylos uva-ursi*. The community can be distinguished from the montane *Calluna* heaths (*Calluna-Cladonia* H13, *Calluna-Racomitrium* H14, *Calluna-Juniperus* H15 and *Calluna-Arctostaphylos alpinus* H17) because the heather is never prostrate or severely dwarfed by the wind, and montane species are generally absent.

Some forms of *Calluna-Vaccinium* heath closely resemble *Calluna-Erica* heath, and transitional stands can occur. The two communities can usually be distinguished by the relative amounts of *Vaccinium myrtillus* and *Erica cinerea*: *V. myrtillus* is the commoner species in *Calluna-Vaccinium* heath, and the reverse is true of

*Calluna-Erica* heath. Among other differences, pleurocarpous mosses are generally more common in *Calluna-Vaccinium* heath, and *Potentilla erecta* is more common in *Calluna-Erica* heath. *Calluna-Vaccinium* heath differs from *Calluna-Ulex gallii* heath H8 in the absence or scarcity of *Ulex gallii*, and from *Ulex gallii-Agrostis* heath H4 in the absence or scarcity of both *U. gallii* and *Agrostis curtisii*. It generally has more *V. myrtillus* and less *Pohlia nutans* than *Calluna-Deschampsia* heath H9; the *Vaccinium-Cladonia* sub-community H9b may contain much *V. myrtillus* but it lacks the dense underlay of pleurocarpous mosses typical of *Calluna-Vaccinium* heath.

#### ECOLOGY

*Calluna-Vaccinium* heath occurs over a wide variety of siliceous rocks, including sandstone, gritstone, meta-sediments and granite, or on drift and gravel derived from acid rock. The soils are mostly moist but free-draining, nutrient-poor, acid podsols, but the community can also occur on rankers, brown earths and brown podsol soils. *Calluna-Vaccinium* heath occurs on hillsides, on crags and ledges, among scree and boulders on sun-exposed slopes, and on the sides of ravines. Most stands are between 200 m and 600 m, and on the heathery hills of the eastern Highlands *Calluna-Vaccinium* heath commonly forms a well-marked band of dark heathy vegetation at moderate altitudes, giving way upslope to montane *Calluna* and *Vaccinium* heaths.

#### DISTRIBUTION

This form of heath occurs widely in the British uplands from south-west England to Shetland, and has been recorded from most upland areas apart from parts of the Hebrides. It accounts for most of the *Calluna* heathland in the central and eastern Highlands, the eastern parts of the Southern Uplands, the Pennines, the eastern Lake District and eastern Wales. It is most common in the northern Pennines and eastern Scotland. It is more widespread than *Calluna-Erica* heath in the uplands of eastern Britain, where the climate is cooler and less oceanic than in more westerly regions; it also tends to occur at higher altitudes. However, the two communities form mosaics in many areas, with *Calluna-Vaccinium* heath usually on deeper soils than *Calluna-Erica* heath.

*Calluna-Vaccinium* heaths resembling this community have been recorded in eastern Ireland (Hobbs and Averis 1991b) and in western Norway.

### ***Calluna vulgaris-Cladonia arbuscula* heath (H13)**

#### DESCRIPTION

*Calluna-Cladonia* heaths are thin, tightly-woven mats of vegetation, in which the creeping, prostrate shoots of heather spread out over dry stony soils, usually with a thick white frosting of lichens. Other typical species include montane plants that can endure frost and biting winds, such as *Carex bigelowii*, *Empetrum nigrum* ssp. *hermaphroditum*, *Vaccinium uliginosum*, and the clubmosses *Diphasiastrum alpinum* and *Huperzia selago*. There can be a sprinkling of *Nardus stricta*, *Agrostis canina* and other grasses. The crisp carpet of lichens is composed of *Cladonia arbuscula*, *C. portentosa*, *C. uncialis* ssp. *biuncialis*, *C. rangiferina*, *Coelocaulon aculeatum*, *Alectoria nigricans*, *Cetraria islandica* and other robust species. Bryophytes are less common than lichens, but there can be a thin weft of *Hypnum jutlandicum*, a little *Racomitrium lanuginosum*, and a few tufts of *Polytrichum alpinum* or *P. juniperinum*. In some stands, for example on solifluction lobes on gently-sloping ground, the vegetation forms distinctive patterns in which the heather grows in parallel lines or rows of crescents with the shoot tips pointing away from the prevailing wind.

There are three sub-communities. The *Cladonia arbuscula-Cladonia rangiferina* sub-community H13a includes the less montane stands; *Erica cinerea*, *E. tetralix*, *Molinia caerulea*, *Nardus* and *Festuca ovina* can occur here, although they are not common. Although Rodwell (1991b) states that lichens are more common in the *Cladonia* sub-community than in the other sub-communities and that they tend to cover more ground than the dwarf shrubs, this difference is not apparent from the published data tables. In the more montane *Empetrum nigrum* ssp. *hermaphroditum-Cetraria nivalis* sub-community H13b, the montane lichen *Cetraria nivalis* grows in conspicuous creamy-yellow patches among the dwarf shrubs; *Deschampsia flexuosa* is also common. The *Cladonia crispata-Loiseleuria procumbens* sub-community H13c is distinguished by the dwarf shrubs *Vaccinium myrtillus* and *Loiseleuria procumbens*, and the lichens *Cladonia crispata*, *Ochrolechia frigida* and *Thamnolia vermicularis*.

Throughout the Highlands and in the Lake District and north Wales there are prostrate *Calluna* heaths with very few lichens and little or no *Racomitrium lanuginosum*. These heaths typically have few montane species. They have similarities to both *Calluna-Cladonia* heath and its western counterpart *Calluna-Racomitrium* heath

H14, but have no clear place within the NVC. They correspond to Birks and Ratcliffe's (1980) Species-poor dwarf *Calluna* heath B2a.

#### DIFFERENTIATION FROM OTHER COMMUNITIES

*Calluna-Cladonia* heath is distinguished from the sub-montane *Calluna-Erica* H10, *Calluna-Vaccinium* H12 and *Calluna-Arctostaphylos uva-ursi* H16 dry heaths by the extremely short and typically prostrate growth-form of the heather and other dwarf shrubs. There are also more montane species. Some stands of the *Cladonia* sub-community of *Trichophorum-Erica* wet heath M15c have a conspicuous underlayer of lichens, but again the heather is not prostrate, and wet heath species, such as *Erica tetralix*, *Trichophorum cespitosum*, *Molinia* and *Sphagna*, are common. Among the montane heaths, *Calluna-Cladonia* heath can be confused only with *Calluna-Racomitrium* heath, but it has more lichens and correspondingly less *Racomitrium lanuginosum*.

#### ECOLOGY

*Calluna-Cladonia* heath is a montane community of high, exposed, windswept spurs, shoulders and summits: places that catch the bitter winds of winter, are blown clear of snow, and are afflicted by frosts. It usually occupies convex slopes with acid, podsolised, free-draining, stony soils. *Calluna vulgaris* reaches its highest altitudes in Britain and Ireland in this type of vegetation, at over 1100 m in the Cairngorms (Ratcliffe 1977; Nethersole-Thompson and Watson 1981). Most stands lie above the altitudinal limit of woodland and so are truly montane, but some small stands occur on the exposed tops of moraines below 600 m. *Calluna-Cladonia* heath is the eastern, boreal counterpart of the more oceanic montane *Calluna-Racomitrium* heath.

#### DISTRIBUTION

The distribution of *Calluna-Cladonia* heath is centred on the east and central Highlands: the great plateaux of the Cairngorms, Lochnagar and the Drumochter hills. It extends west to Beinn Dearg at the head of Loch Broom and other hills in Wester Ross, and to Ben Dubhchraig in western Perthshire. There are a few stands in the Southern Uplands, the Lake District and the northern Pennines. In north Wales, semi-prostrate *Calluna* heaths with few lichens and no *Racomitrium lanuginosum* occur on the Carneddau and Rhinog ranges and on Cadair Idris (Averis and Averis 2000b).

There is vegetation similar to *Calluna-Cladonia* heath in western Norway (McVean and Ratcliffe 1962) and Ireland, but it is not recorded in the Faroes.

### ***Calluna vulgaris-Racomitrium lanuginosum* heath (H14)**

#### DESCRIPTION

Like *Calluna-Cladonia* heath H13, this is a montane heath, in which the stems of heather either lie flat along the ground or are more erect but severely pruned by the wind to a height of only about 5 cm. The heather is surrounded by a dense, silvery-grey carpet of *Racomitrium lanuginosum*. Pricking up through this low mat of moss and heather are a few small vascular plants, including *Carex bigelowii*, *Erica cinerea*, *Diphasiastrum alpinum*, *Dactylorhiza maculata* and, in some stands, *Loiseleuria procumbens*, *Arctostaphylos alpinus* or *Juniperus communis* ssp. *nana*. In many places the vegetation is discontinuous and distributed in patches over bare stony ground. The patches may be aligned in noticeable stripes parallel to the direction of the prevailing wind; these can occur on solifluction lobes and terraces.

There are three sub-communities. The *Festuca ovina* sub-community H14a is a grassy form of heath with *Potentilla erecta*, *Huperzia selago*, *Carex pilulifera*, *Festuca vivipara* or *F. ovina* and *Agrostis canina*. The *Empetrum nigrum* ssp. *hermaphroditum* sub-community H14b is the most montane form of the community, and is characterised by *Empetrum nigrum* ssp. *hermaphroditum* and the lichens *Cetraria islandica*, *Cladonia gracilis* and *Ochrolechia frigida*. The *Arctostaphylos uva-ursi* sub-community H14c has a more mixed carpet of dwarf shrubs including *Arctostaphylos uva-ursi*, *A. alpinus*, *Erica cinerea* and *Empetrum nigrum* ssp. *nigrum*. In practice it can be difficult to separate the sub-communities; many stands have an intermediate flora.

Throughout the Highlands and in the Lake District and north Wales there are prostrate *Calluna* heaths with little or no *R. lanuginosum* and few lichens. They resemble both *Calluna-Racomitrium* heath and its eastern counterpart, *Calluna-Cladonia* heath, but have no obvious place in the current NVC scheme.

#### DIFFERENTIATION FROM OTHER COMMUNITIES

*Calluna-Racomitrium* heath may be confused with other forms of prostrate montane heath. *Calluna-Cladonia* heath has less *Racomitrium lanuginosum* and more lichens. *Calluna-Juniperus* heath H15 has more

*Juniperus communis* ssp. *nana*, and the heather is usually sparser. *Calluna-Arctostaphylos alpinus* heath H17 has more *Arctostaphylos alpinus* together with other montane dwarf shrubs, such as *Loiselurea procumbens*.

Some forms of *Calluna-Racomitrium* heath resemble *Carex-Racomitrium* moss-heath U10 but have more *Calluna*. Western stands of the *Cladonia* sub-community of *Trichophorum-Erica* wet heath M15c can have a similar flora to *Calluna-Racomitrium* heath, including much *R. lanuginosum*, but have more *Trichophorum cespitosum*, *Molinia caerulea* and *Erica tetralix*. *Calluna-Erica* heath H10 also has a similar flora to *Calluna-Racomitrium* heath but the canopy is never as short and tight, is less obviously wind-pruned, and has less *R. lanuginosum* and no montane species.

#### ECOLOGY

*Calluna-Racomitrium* heath is a community of exposed open ground on ridges and high shoulders that are blown clear of snow. It generally occurs on flat or gently-sloping ground. It develops mainly over acid rocks, on free-draining rankers or podsols. Many stands are on gravelly moraines. The community appears to be natural climax vegetation, with its structure and flora determined by climate and topography, although in some places it is grazed. Although most common at higher altitudes, it descends to below 200 m in the far north-west - lower than other montane *Calluna* heaths (McVean and Ratcliffe 1962).

#### DISTRIBUTION

*Racomitrium lanuginosum* is a common plant in upland vegetation only in the west, and *Calluna-Racomitrium* heath has a markedly western distribution in Great Britain. The community is known mainly from the north-west Highlands, Skye, the Outer Hebrides, Orkney and Shetland. It also occurs sparingly in the eastern Highlands, on Mull and Islay, and in north Wales.

Montane heath vegetation of this type also occurs in Ireland (Hobbs and Averis 1991b) but has not been described from elsewhere in the world.

### ***Calluna vulgaris-Juniperus communis* ssp. *nana* heath (H15)**

#### DESCRIPTION

This is one of our more striking upland heaths, with the silvery-green bushes of *Juniperus communis* ssp. *nana* sprawling over bare or stony ground, surrounded by prostrate *Calluna vulgaris*, and with a sparse open mat of bryophytes, such as *Racomitrium lanuginosum* and *Hypnum jutlandicum*. The plants grow in a habitat that looks bleak and desolate, yet among the cushions and mats of mosses beneath the low and prickly mats of juniper, conditions can be sheltered enough for an array of small vascular plants and bryophytes including *Erica cinerea*, *Huperzia selago*, *Potentilla erecta*, *Pleurozia purpurea*, *Mylia taylorii* and *Scapania gracilis*. Notable oceanic liverworts, such as *Herbertus aduncus* ssp. *hutchinsiae* and *Plagiochila carringtonii* occur locally, and testify to the humid and sheltered microclimate beneath the dwarf shrubs in an otherwise exposed environment. The dwarf shrubs *Arctostaphylos uva-ursi* and *A. alpinus* are common in some stands.

#### DIFFERENTIATION FROM OTHER COMMUNITIES

This community has more *Juniperus communis* ssp. *nana* than any of the other prostrate *Calluna* heaths (*Calluna-Cladonia* heath H13, *Calluna-Racomitrium* heath H14 and *Calluna-Arctostaphylos alpinus* heath H17). In the west Highlands, *J. communis* ssp. *nana* occurs in some stands of the *Cladonia* sub-community of *Trichophorum-Erica* wet heath M15c, but the wet heath has *Erica tetralix*, *Trichophorum cespitosum* and *Molinia caerulea*, all of which are scarce in *Calluna-Juniperus* heath. In a few places, prostrate juniper grows in *Calluna-Erica* H10 and *Calluna-Vaccinium-Sphagnum* H21 heaths, but both of these communities have taller and thicker canopies of dwarf shrubs than *Calluna-Juniperus* heath, and *Calluna-Vaccinium-Sphagnum* heath also contains *Sphagnum capillifolium*.

#### ECOLOGY

*Calluna-Juniperus* heath occurs on shattered rock debris, cliff ledges and stony plateaux, generally where the parent rocks are hard and acid. Some of the largest examples are on quartzite, but there are also good stands on Torridonian sandstone, Lewisian gneiss, gabbro and granite. The soils are thin humic rankers lying directly over the bedrock.

The community occurs at moderate to high altitudes in the western Highlands, descending almost to sea-level in the extreme north-west. It is most common around the former tree-line. It is a near-natural climax vegetation type which was probably once much more extensive, and which may at one time have formed a zone of

scrubby heath on acid soils above and within the tree-line throughout the western Highlands and Islands, the Lake District and north Wales.

#### DISTRIBUTION

The community is almost confined to the north-west Highlands of Scotland, the Outer Hebrides, Skye, Jura, Islay and Arran; records from Jura and Islay are insufficiently localised to be shown on the distribution map. There are fragmentary outliers on the Borrowdale Fells in the Lake District and in Snowdonia in north Wales. The largest stands are on the Cambrian quartzite hills of Foinaven and Cranstackie in Sutherland (McVean and Ratcliffe 1962; Ratcliffe 1977; Averis & Averis 1997a), on Beinn Eighe in Wester Ross (McVean and Ratcliffe 1962; Averis and Averis 1998a), and on the Cuillins of Skye (Averis and Averis 1997c, 1998b, 1999c). There are also some fine stands in South Harris (A B G Averis 1994).

There is similar vegetation in western Ireland (Horsfield *et al.* 1991).

### ***Calluna vulgaris*-*Arctostaphylos uva-ursi* heath (H16)**

#### DESCRIPTION

These are short, dense to rather open dwarf-shrub heaths in which the dark and sombre tones of *Calluna vulgaris*, *Erica cinerea* and *Vaccinium vitis-idaea* are enlivened by the shining, bright-green, net-veined leaves of *Arctostaphylos uva-ursi* and in some places by scattered plants of *Genista anglica*, with its narrow green shoots and golden flowers. The shrubs are overtopped by the thin dark leaves of *Deschampsia flexuosa*, and at the feet of the vascular plants there is a discontinuous thin weft of mosses and lichens, such as *Pleurozium schreberi*, *Hylocomium splendens*, *Hypnum jutlandicum* and *Cladonia portentosa*.

There are three sub-communities: one herb-rich, one heathy, and one species-poor with many lichens. The *Pyrola media*-*Lathyrus linifolius* sub-community H16a is the herb-rich form, and has mesotrophic species, such as *Pyrola media*, *Lathyrus linifolius*, *Viola riviniana*, *Lotus corniculatus*, *Anemone nemorosa* and *Rhytidiadelphus triquetrus*, among the dwarf shrubs. The heathy *Vaccinium myrtillus*-*Vaccinium vitis-idaea* sub-community H16b has a less varied sward containing more *Vaccinium myrtillus* and commonly some *Empetrum nigrum* ssp. *nigrum*. In the *Cladonia* species sub-community H16c there is much *Trichophorum cespitosum* and *Carex pilulifera* together with a thin frosting of *Cladonia uncialis* ssp. *biuncialis*, *C. floerkeana*, *C. coccifera*, *Coelocaulon aculeatum* and other lichens.

In western Scotland, there is a related type of heath composed mainly of *Calluna* and *A. uva-ursi*, with much *E. cinerea* but little or no *V. vitis-idaea* or *V. myrtillus*, which is not described in the NVC. *Salix repens* is common in some of these stands.

#### DIFFERENTIATION FROM OTHER COMMUNITIES

The flora of *Calluna*-*Arctostaphylos uva-ursi* heath is similar to that of *Calluna*-*Vaccinium* heath H12, from which it differs in being co-dominated by *Calluna* and *Arctostaphylos uva-ursi*. *Erica cinerea* is common in both *Calluna*-*Arctostaphylos uva-ursi* heath and *Calluna*-*Erica* heath H10, but *Vaccinium* species are rare in *Calluna*-*Erica* heath and *A. uva-ursi* is not co-dominant with *Calluna*. *Genista anglica* is more common in *Calluna*-*Arctostaphylos uva-ursi* heath than in any other type of British heathland.

The western heaths dominated by *Calluna* and *Arctostaphylos uva-ursi* and with much *E. cinerea* differ from typical *Calluna*-*Arctostaphylos uva-ursi* heath mainly in the absence of *Vaccinium* species. The co-dominance of *Calluna* and *A. uva-ursi* distinguishes them from *Calluna*-*Erica* heath. They can be regarded as a counterpart of *Calluna*-*Erica* heath with much *A. uva-ursi*, just as typical *Calluna*-*Arctostaphylos uva-ursi* heath is a counterpart of *Calluna*-*Vaccinium* heath. In both cases the vegetation is worthy of recognition as a separate heathland type in which *A. uva-ursi* has gained a strong competitive edge as a result of some kind of disturbance or stress to the habitat.

#### ECOLOGY

This is a community of stony, acid, free-draining brown soils and podsoles at altitudes up to about 750 m; the species-rich *Pyrola*-*Lathyrus* sub-community occurs on richer brown-earth soils. In the sub-montane zone of the eastern Highlands *Calluna*-*Arctostaphylos uva-ursi* heath is generally maintained by fire. *Arctostaphylos uva-ursi* can compete well with *Calluna vulgaris* when heaths are burned, but can be overwhelmed when the heather becomes taller and denser. Stands above 600-700 m may be natural vegetation maintained by the severe climate. In such situations the shrubs can be dwarfed, the heaths clinging to thin stony soils on the upper slopes, and grading into prostrate *Calluna*-*Cladonia* heaths H13 on windswept summits and ridges.

The western form of *Calluna-Arctostaphylos uva-ursi* heath with much *Erica cinerea* seems to be a more or less natural and stable vegetation type. Here *A. uva-ursi* evidently gains a competitive edge where the growth of *Calluna* is restricted by thin, patchy soils on very rocky ground, or suppressed by strong westerly winds and salt spray.

#### DISTRIBUTION

*Calluna-Arctostaphylos uva-ursi* heath occurs mostly in the eastern and central Highlands, with outliers in the Southern Uplands and fragmentary stands in the Lake District, in Upper Teesdale (not shown on the distribution map) and on Orkney (Birks and Ratcliffe 1980). The western *Calluna-Arctostaphylos uva-ursi* heaths have a scattered distribution through the western Highlands and Hebrides, from Colonsay and Mull north to Sutherland.

There are communities related to *Calluna-Arctostaphylos uva-ursi* heath in Norway, Sweden and Denmark.

### ***Calluna vulgaris-Arctostaphylos alpinus* heath (H17)**

#### DESCRIPTION

This community comprises tight, prostrate carpets of dwarf shrubs, with the shoot tips growing away from the prevailing wind. The canopy of dwarf shrubs is more varied than that of other montane heaths. There is a flattened layer of *Calluna vulgaris* hugging the ground in a tight, purple-brown mat, but this is enlivened by many other species: *Arctostaphylos alpinus* and *A. uva-ursi* with their shiny, bright-green, oval leaves, the small shoots of *Loiseleuria procumbens*, the yellow-green leaf-whorls of *Empetrum nigrum* (both ssp. *nigrum* and ssp. *hermaphroditum*), and in many places the prickly stems of *Juniperus communis* ssp. *nana*. Plants piercing through the mat of shrubs include *Huperzia selago* and *Deschampsia flexuosa*. The vascular plants are underlain by a patchy silvery layer of the moss *Racomitrium lanuginosum*, and interspersed with lichens, including the crisp white shoots of *Cladonia* species and the dark shiny thalli of *Cetraria islandica* and *Coelocaulon aculeatum*.

The two sub-communities differentiate between the more montane stands of the community and those that occur at lower altitudes. The *Loiseleuria procumbens-Platismatia glauca* sub-community H17a is the more montane form, with plants such as *Carex bigelowii*, *Diphasiastrum alpinum*, *Empetrum nigrum* ssp. *hermaphroditum* and *Vaccinium uliginosum* in the sward, together with *Coelocaulon aculeatum*, *Alectoria nigricans*, *Sphaerophorus globosus*, *Cetraria islandica* and other lichens. In the *Empetrum nigrum* ssp. *nigrum* sub-community H17b, *E. nigrum* ssp. *nigrum*, *Potentilla erecta*, *Trichophorum cespitosum*, *Erica cinerea* and *Hypnum jutlandicum* take the place of the more montane species of the *Loiseleuria-Platismatia* sub-community, and there are fewer lichens.

#### DIFFERENTIATION FROM OTHER COMMUNITIES

*Calluna-Arctostaphylos alpinus* heath is similar to the other montane prostrate dwarf-shrub heaths: *Calluna-Cladonia* heath H13, *Calluna-Racomitrium* heath H14 and *Calluna-Juniperus* heath H15. It can be distinguished from all of these communities by its more mixed canopy of dwarf shrubs which includes *Arctostaphylos alpinus*.

#### ECOLOGY

This form of heath occurs on high, bleak, windswept spurs and shoulders and where stony moraines break through blanket peat. The carpet of dwarf shrubs spreads over fine-grained, well-drained, usually acid soils and rock debris. Most stands are above 500 m, although the community occurs below 200 m in the extreme north-west Highlands. Winters are long and bitter at these altitudes and latitudes, and the dwarf shrubs are pruned by exposure to frost and wind.

#### DISTRIBUTION

The distribution of *Calluna-Arctostaphylos alpinus* heath is defined largely by that of *A. alpinus*, which is rare south of the Great Glen. All records of the community are from the north-western Highlands and Orkney.

There is similar vegetation in Scandinavia, although it generally has little *Calluna*.

### ***Vaccinium myrtillus-Deschampsia flexuosa* heath (H18)**

#### DESCRIPTION

Many hectares of hillsides in the uplands are clothed with stands of this rich-green, mossy heathland. It usually has a thick vigorous canopy of *Vaccinium myrtillus*, pierced through by the long narrow leaves and delicate flowers of *Deschampsia flexuosa*. *Galium saxatile* trails its dark-green shoots over the ground, and there is a deep carpet of mosses, such as *Pleurozium schreberi*, *Dicranum scoparium*, *Hylocomium splendens* and *Hypnum jutlandicum*.

Three sub-communities are described in the NVC, although they are rather tenuously separated from each other. The *Hylocomium splendens-Rhytidiadelphus loreus* sub-community H18a is the typical and most common form of the community. The thick canopy of dwarf shrubs covers a dense soft layer of mosses, including *Hylocomium splendens* and *Rhytidiadelphus loreus*, and is studded with short rosettes of *Blechnum spicant*. The *Alchemilla alpina-Carex pilulifera* sub-community H18b is grassier, with short sprigs of *V. myrtillus* set in a matrix of *Festuca ovina*, *Agrostis capillaris* and *Anthoxanthum odoratum*. There is usually a loose mat of *Alchemilla alpina* with its yellow-green flowers in summer; *Potentilla erecta* is common too. The common grassland moss *Rhytidiadelphus squarrosus* also grows here. Some grassy stands without *A. alpina* have been included in this sub-community, which confuses what is otherwise a well-defined unit of vegetation; such stands might be better classed as intermediate between the *Hylocomium-Rhytidiadelphus* sub-community and the *Vaccinium* sub-community of *Festuca-Agrostis-Galium* grassland U4e. The *Racomitrium lanuginosum-Cladonia* species sub-community H18c is a relatively species-poor heath, generally with a rather short and open sward. The species that define the other two sub-communities may occur here but are not so common. There can be a conspicuous pale frosting of the lichens *Cladonia arbuscula*, *C. portentosa*, *C. gracilis* and *C. uncialis* ssp. *biuncialis* encrusting the ground, and *Hypogymnia physodes* may grow in thick greyish clots on the stems of the dwarf shrubs.

In northern England and eastern Wales there are heaths that closely resemble the *Hylocomium-Rhytidiadelphus* sub-community except that *V. vitis-idaea* takes the place of *V. myrtillus*. These heaths are common on rocky slopes just below the Millstone Grit 'edges' in the southern Pennines.

The current classification of *Vaccinium-Deschampsia* heaths does not adequately show the relationships between flora, environment and management. This is probably the result of inadequate sampling, and the fact that both near-natural and anthropogenic forms of *Vaccinium-Deschampsia* heath have been grouped together because of their floristic similarity. It may be more satisfactory to separate the more natural montane heaths containing *Empetrum nigrum* ssp. *hermaphroditum*, *Vaccinium uliginosum* and other montane plants, from the less natural sub-montane heaths with *E. nigrum* ssp. *nigrum* or no *Empetrum* at all. The *Rhytidiadelphus-Hylocomium* sub-community of *Vaccinium-Racomitrium* heath H20d would probably be better incorporated with the montane form of the *Hylocomium-Rhytidiadelphus* sub-community of *Vaccinium-Deschampsia* heath. It seems sensible to separate off the sub-montane lichen-rich *Vaccinium-Deschampsia* heaths. The form of the *Alchemilla-Carex* sub-community with much *Alchemilla alpina* is a well-defined type.

#### DIFFERENTIATION FROM OTHER COMMUNITIES

*Vaccinium-Deschampsia* heath can be confused only with other heath communities in which *V. myrtillus* is dominant.

The lichen-rich *Racomitrium-Cladonia* sub-community can resemble *Vaccinium-Cladonia* heath H19, although it occupies different habitats. It occurs mainly at moderate altitudes on dried-out peat within eroding blanket bogs, on grazed slopes and in snow-beds, whereas *Vaccinium-Cladonia* heath is characteristic of upper slopes and ridges at high altitudes. *Vaccinium-Cladonia* heath usually has a more continuous underlay of lichens, and has more montane species, such as *Carex bigelowii*, *Empetrum nigrum* ssp. *hermaphroditum*, *Salix herbacea*, *Loiseleuria procumbens* and the lichens *Cetraria islandica*, *Ochrolechia frigida* and *Thamnolia vermicularis*. *Vaccinium-Deschampsia* heath has more acid grassland species, including *Potentilla erecta*, *Galium saxatile*, *Agrostis capillaris* and *Anthoxanthum odoratum*.

The *Rhytidiadelphus-Hylocomium* sub-community of *Vaccinium-Racomitrium* heath H20d can be similar to the *Hylocomium-Rhytidiadelphus* sub-community of *Vaccinium-Deschampsia* heath, and indeed it is closer floristically to this vegetation type than to the other sub-communities of *Vaccinium-Racomitrium* heath. However, montane species, such as *C. bigelowii* and *E. nigrum* ssp. *hermaphroditum*, are generally more common in *Vaccinium-Racomitrium* heath. The other three sub-communities of *Vaccinium-Racomitrium* heath are more obviously distinct from *Vaccinium-Deschampsia* heath, as they have much more *Racomitrium lanuginosum* and fewer pleurocarpous mosses.

The *Alchemilla-Carex* sub-community can be confused with the Typical sub-community of *Festuca-Agrostis-Alchemilla* grassland CG11a, but has more *Vaccinium myrtillus*, *Deschampsia flexuosa* and *Pleurozium schreberi*, and very little *Thymus polytrichus*. *Alchemilla alpina* and *V. myrtillus* are common in a local form of mossy *Festuca-Agrostis-Galium* grassland U4e, which also has much *D. flexuosa*. This grassland differs from *Vaccinium-Deschampsia* heath in that *V. myrtillus* is clearly subordinate to grasses and *A. alpina* (it is at least co-dominant in the heath), there is more *R. lanuginosum* and a less continuous layer of pleurocarpous mosses, and there may be some montane species, such as *Gnaphalium supinum* and *Luzula spicata*.

Grazed heath resembling *Calluna-Vaccinium-Sphagnum* heath H21 but without *Calluna* can be distinguished from *Vaccinium-Deschampsia* heath because it has much *Sphagnum capillifolium*.

#### ECOLOGY

This vegetation type takes in *Vaccinium* heaths that range from near-natural to quite clearly anthropogenic. They occur within the altitudinal range of *Calluna vulgaris* in situations where *Calluna* has been excluded by prolonged late snow-lie or by grazing. The *Hylacomium-Rhytidiadelphus* sub-community occurs on high slopes in the Highlands and more locally in the Southern Uplands, the Lake District and north Wales where snow lies moderately late. However, it is equally characteristic of slopes at low to moderate altitudes in the uplands of southern Scotland, England and Wales as a derivative of *Calluna-Vaccinium* heath H12. This happens when *Calluna-Vaccinium* heaths are burned and then grazed too hard to allow *Calluna* to re-establish itself. The *Alchemilla-Carex* sub-community includes grassy heaths on the middle slopes of the Breadalbanes, which are obviously grazed derivatives of more natural vegetation - perhaps sub-alpine birch-woods or scrub with *Salix lapponum*. It also includes shallow snow-beds on steep unstable slopes. The *Racomitrium-Cladonia* sub-community can cover eroded peats and grazed slopes at moderate altitudes, or occur around *Nardus-Carex* snow-beds U7 in the Highlands.

Despite the wide variation in habitat, the community is consistently associated with well-drained, acid to neutral mineral soils, humic rankers and dry peats. Stands can occur on slopes of all aspects, but the more natural examples are confined to cold, shaded slopes facing north or east where snow lies late. The community has a wide altitudinal range, from near sea-level to over 900 m; most stands lie between 400 m and 800 m.

#### DISTRIBUTION

*Vaccinium-Deschampsia* heaths occur throughout the British uplands from south-west England to northern Scotland. The largest stands are in the central and eastern Highlands, but the community is also very common in Wales. It becomes less common towards the north and west, and is not recorded from Orkney, Shetland and the Outer Hebrides.

There is similar vegetation in western Norway.

### ***Vaccinium myrtillus-Cladonia arbuscula* heath (H19)**

#### DESCRIPTION

This is a strikingly attractive montane heath, in which the rich green shoots of *Vaccinium myrtillus* and *Empetrum nigrum* ssp. *hermaphroditum* are set in a crisp, white, tangled matrix of lichens. Growing through the low canopy of dwarf shrubs (up to about 15 cm high but usually much less) there are a few other species including the montane *Carex bigelowii*, *Diphasiastrum alpinum*, *Salix herbacea* and *Loiseleuria procumbens*, and less demanding plants, such as *Huperzia selago*, *Deschampsia flexuosa* and *Vaccinium vitis-idaea*. The layer of lichens is composed of *Cladonia arbuscula*, *C. portentosa*, *Coelocaulon aculeatum*, *Alectoria nigricans* and other widespread species, but the montane *Cetraria islandica* and *Ochrolechia frigida* are also common here. The lichens are crowded so thickly and deeply that the vegetation often feels springy or spongy to walk on. A few mosses may also occur, especially large pleurocarpous species, such as *Pleurozium schreberi* and *Hypnum jutlandicum*, but these are never as obvious as the lichens.

There are three sub-communities. The *Festuca ovina-Galium saxatile* sub-community H19a is a grassy assemblage with much *Festuca ovina* or *F. vivipara* and *Galium saxatile* among the dwarf shrubs. The *Racomitrium lanuginosum* sub-community H19b has slightly more *Racomitrium lanuginosum*, and there are a few more montane plants, such as *Alchemilla alpina*, *Salix herbacea* and *Silene acaulis*. It is typical of shallow snow-beds in the eastern Highlands as well as high slopes in the wetter west of the country. The *Empetrum nigrum* ssp. *hermaphroditum-Cladonia* species sub-community H19c is the most lichen-rich form; it is further

distinguished by *Empetrum nigrum* ssp. *hermaphroditum*, *Dicranum scoparium*, *Pleurozium schreberi*, *Cladonia rangiferina* and *C. gracilis*.

#### DIFFERENTIATION FROM OTHER COMMUNITIES

This distinctive type of heath is most similar to the sub-montane *Vaccinium-Deschampsia* heath H18 and the montane *Vaccinium-Racomitrium* heath H20. Compared to *Vaccinium-Deschampsia* heath, *Vaccinium-Cladonia* heath has a more continuous underlayer of lichens, and more montane species, such as *Empetrum nigrum* ssp. *hermaphroditum*, *Carex bigelowii*, *Salix herbacea* and *Loiseleuria procumbens*. It has more lichens and fewer mosses than *Vaccinium-Racomitrium* heath; *Racomitrium lanuginosum* is generally rare in *Vaccinium-Cladonia* heath.

#### ECOLOGY

*Vaccinium-Cladonia* heath is a community of high slopes, including places where snow lies moderately late. It forms a zone above the montane *Calluna-Cladonia* H13 and *Calluna-Racomitrium* H14 heaths, and below the *Carex-Racomitrium* moss-heaths U10 of the highest ground. Most stands are at altitudes above 650 m. The soils are strongly leached and base-poor, even over calcareous parent rocks, such as the mica-schist of the Breadalbanes.

#### DISTRIBUTION

*Vaccinium-Cladonia* heath is fairly widely distributed in the higher uplands from north Wales and the Lake District north to Sutherland. It has not been recorded in the Hebrides or the Northern Isles. The community is most characteristic of the more continental parts of the country: the largest stands are in the eastern Breadalbanes, the Cairngorms, on Lochnagar and on Ben Wyvis. Stands in the west are smaller and less distinctive.

Lichen-rich vegetation such as this is one of the nearest approaches in Britain to the continental heaths of Scandinavia with their deep, species-rich mats of lichens. Vegetation similar to *Vaccinium-Cladonia* heath occurs locally in central and eastern Norway.

### ***Vaccinium myrtillus-Racomitrium lanuginosum* heath (H20)**

#### DESCRIPTION

This is an attractive, rich-bright-green montane heath. It is composed of a short, even mixture of *Vaccinium myrtillus* and *Empetrum nigrum* ssp. *hermaphroditum* bound together by a deep lush turf of mosses, of which the most common are the silvery-green *Racomitrium lanuginosum*, the golden *Rhytidiadelphus loreus*, *Hylocomium splendens* and *Pleurozium schreberi*, and the pale green *Hypnum jutlandicum*. The sward is speckled with small vascular plants, such as *Nardus stricta*, *Deschampsia flexuosa*, *Carex bigelowii*, *Alchemilla alpina*, *Diphasiastrum alpinum* and *Galium saxatile*.

There are four sub-communities. The *Viola riviniana-Thymus polytrichus* sub-community H20a is a rather herb-rich heath in which the dwarf shrubs are mixed with *Potentilla erecta*, *Huperzia selago*, *Alchemilla alpina*, *Thymus polytrichus* and *Viola riviniana*. The *Cetraria islandica* sub-community H20b is the most lichen-rich form of the community, with *Cetraria islandica*, *Cladonia gracilis* and *Coelocaulon aculeatum* among the mat of *Racomitrium lanuginosum*. The *Bazzania tricrenata-Mylia taylorii* sub-community H20c is perhaps the most distinctive form; it is a damp heath with a rich-red underfelt of *Sphagnum capillifolium* interleaved with liverworts including *Bazzania tricrenata*, *Mylia taylorii*, and the oceanic *Pleurozia purpurea*, *Bazzania pearsonii*, *Scapania ornithopodioides*, *S. nimbosea*, *Plagiochila carringtonii* and *Anastrophyllum donnianum*. The *Rhytidiadelphus loreus-Hylocomium splendens* sub-community H20d includes less distinctive stands with few distinguishing species apart from *Vaccinium vitis-idaea*, *Hylocomium splendens* and *Rhytidiadelphus loreus*; pleurocarpous mosses are commoner than *R. lanuginosum*.

#### DIFFERENTIATION FROM OTHER COMMUNITIES

*Vaccinium-Racomitrium* heath may be confused with other forms of bilberry heath. It has more montane species, fewer grasses and more *Racomitrium lanuginosum* than *Vaccinium-Deschampsia* heath H18. It is mossier than *Vaccinium-Cladonia* heath H19, with more *R. lanuginosum* and fewer lichens. Sparser stands of *Vaccinium-Racomitrium* heath could be mistaken for *Carex-Racomitrium* moss-heath U10, but generally the sward of *Vaccinium myrtillus* is thicker and more continuous.

#### ECOLOGY

*Vaccinium-Racomitrium* heath is typical of rocky slopes, boulder fields and exposed ridges at high altitudes in areas with a cold, very wet, oceanic climate. The underlying rocks are usually acid although the community does extend onto richer basalt and Moine schist. Soils are damp humic rankers lying directly on broken rocks (McVean and Ratcliffe 1962). The *Bazzania-Mylia* sub-community is virtually confined to slopes facing north or east, but the other sub-communities can occur on slopes of any aspect. The community occurs between the *Calluna-Erica* H10, *Calluna-Vaccinium* H12, *Calluna-Vaccinium-Sphagnum* H21 and *Vaccinium-Rubus* H22 heaths of lower altitudes, and the more montane *Carex-Nardus* grasslands U7 and *Carex-Racomitrium* moss-heaths U10. It is generally above the tree-line; most examples are above 500 m, although there are dwarfed rowans in some of the more sheltered stands.

#### DISTRIBUTION

This community is recorded almost entirely from the Scottish Highlands and the Hebrides, and is especially widespread in the north-west. It also occurs in the hills of north-west Wales and may yet be found in the Lake District. To some extent it is an oceanic replacement for the *Vaccinium-Cladonia* heaths of the eastern Highlands, although the two types have overlapping distributions. The *Bazzania-Mylia* sub-community is almost confined to the north-west Highlands, extending as far east as the Affric-Cannich hills, Creag Meagaidh and Ben Hope, but there are outlying and species-poor fragments in north Wales (A M Averis and A Turner, pers. obs.).

There seems to be no comparable vegetation elsewhere in Europe, but structurally and floristically similar communities have been noted in Iceland and Tristan da Cunha (McVean and Ratcliffe 1962), and in western Norway.

### ***Calluna vulgaris-Vaccinium myrtillus-Sphagnum capillifolium* heath (H21)**

#### DESCRIPTION

This is a dark, shaggy damp heath in which the rough, purple-green canopy of *Calluna vulgaris* is mixed with clumps of *Erica cinerea* and light-green shoots of *Vaccinium myrtillus*, and speckled in summer with the yellow flowers of *Potentilla erecta*. The vascular plants grow out of a deep, richly-coloured quilt of bryophytes, the most common of which is *Sphagnum capillifolium*. Other Sphagna, such as *S. subnitens*, may also occur, and there can be much *Racomitrium lanuginosum*.

There are two sub-communities. The *Calluna vulgaris-Pteridium aquilinum* sub-community H21a has a red-green carpet of Sphagna below a canopy of dwarf shrubs and in some places a sprinkling of *Pteridium aquilinum*. In the *Mastigophora woodsii-Herbertus aduncus* ssp. *hutchinsiae* sub-community H21b the red hummocks of *Sphagnum* are mixed with a great profusion of elegant oceanic and other western liverworts: the bright orange-red patches of *Herbertus aduncus* ssp. *hutchinsiae*, the pale gold *Mastigophora woodsii* and *Bazzania tricrenata*, the crisp yellow-green tufts of *B. pearsonii*, the ochre shoots of *Scapania gracilis*, the purplish shoots of *S. nimbosea*, *S. ornithopodioides* and *Pleurozia purpurea*, the variegated clumps of *Mylia taylorii*, the pale green upright shoots of *Plagiochila carringtonii*, and the dark hooked stems of *Anastrophyllum donnianum* make a bright tapestry under the sombre canopy of dwarf shrubs. The oceanic filmy fern *Hymenophyllum wilsonii* can grow among boulders and in the mats of liverworts.

In Wales and north-west England there are damp heaths with a dense layer of *Sphagnum* under a thick canopy of *V. myrtillus*, but with no *Calluna*. These are obviously derived from *Calluna-Vaccinium-Sphagnum* heath by heavy sheep grazing.

#### DIFFERENTIATION FROM OTHER COMMUNITIES

The conspicuous cushions of Sphagna in the bryophyte layer distinguish *Calluna-Vaccinium-Sphagnum* heath from the drier *Calluna-Erica* H10 and *Calluna-Vaccinium* H12 heaths. Some forms of *Vaccinium-Rubus* heath H22 have much heather and resemble *Calluna-Vaccinium-Sphagnum* heath, but they have *Rubus chamaemorus* or *Cornus suecica*. However, the definition of *Vaccinium-Rubus* heath as a vegetation type that can be co-dominated by *Calluna* and *Vaccinium* presents problems for its separation from *Calluna-Vaccinium-Sphagnum* heath.

#### ECOLOGY

Most stands of *Calluna-Vaccinium-Sphagnum* heath occupy steep, damp, cool and shaded places: rocky precipitous slopes facing north or east and sheltered ledges on the sides of ravines. However, both sub-communities also occur more rarely on shallow open slopes and on level ground. The soils are thin, humic, greasy, peaty rankers, in many places lying precariously over barely-stable scree. Most stands are on hard,

coarse-grained and acid bedrock, but the community occurs on richer substrates too. The community can occur from a few metres above sea-level to over 700 m (A M Averis 1994), but most stands are between 300 m and 600 m.

#### DISTRIBUTION

The *Calluna-Pteridium* sub-community is common in the Highlands, and extends as far east as the Cheviot Hills and even the North York Moors on shaded slopes that are moist enough for *Sphagna* to grow. Its distribution runs south through Wales to a few steep banks on Dartmoor (not shown on the map). The *Mastigophora-Herbertus* sub-community, with its more exacting oceanic bryophytes, is virtually confined to hills in the western Highlands and Hebrides, with fragmentary outliers in north Wales and the Lake District.

The liverwort-rich *Mastigophora-Herbertus* sub-community is a type of vegetation unique to Britain and Ireland. The most similar related vegetation is in the Faroes and perhaps western Norway (Hobbs and Averis 1991a; A M Averis 1994). Although there are good stands in Kerry, Galway, Mayo and Donegal in western Ireland, nowhere else does the vegetation attain the luxuriance of stands in the north-west Highlands.

### ***Vaccinium myrtillus-Rubus chamaemorus heath (H22)***

#### DESCRIPTION

These are damp, richly-coloured heaths with a canopy of *Calluna vulgaris*, *Vaccinium myrtillus*, *V. vitis-idaea* and *Empetrum nigrum* ssp. *hermaphroditum* growing through a deep, spongy and continuous carpet of large mosses, such as *Hylocomium splendens*, *Pleurozium schreberi*, *Rhytidiadelphus loreus* and *Sphagnum capillifolium*. *V. myrtillus* is usually sufficiently common to give a rich green tone to the vegetation, making it conspicuous from a distance, although the dark tones of heather predominate in many stands, especially in the east. *Potentilla erecta* is usually common, and two especially distinctive and characteristic species are the northern *Rubus chamaemorus* and *Cornus suecica*. *Sphagnum fuscum* occurs in some of the more montane stands of the community.

There are two sub-communities, one a mild snow-bed with more *V. myrtillus* than *Calluna*, and the other with more equal quantities of *Calluna* and *V. myrtillus*. The *Polytrichum commune-Galium saxatile* sub-community H22a has a canopy dominated by *V. myrtillus*; *Polytrichum commune* and *Galium saxatile* are also very common here. The *Plagiothecium undulatum-Anastrepta orcadensis* sub-community H22b has more *Calluna* in a mossy heath with *Plagiothecium undulatum*, *Hypnum cupressiforme*, *H. jutlandicum*, *Racomitrium lanuginosum* and *Anastrepta orcadensis*.

#### DIFFERENTIATION FROM OTHER COMMUNITIES

The *Vaccinium*-dominated *Polytrichum-Galium* sub-community resembles the *Hylocomium-Rhytidiadelphus* sub-community of *Vaccinium-Deschampsia* heath H18a, but has more *Empetrum nigrum* ssp. *hermaphroditum*, *Rubus chamaemorus*, *Cornus suecica*, *Sphagnum capillifolium* and *S. fuscum*, as well as montane species, such as *Carex bigelowii*, *Vaccinium uliginosum* and the lichen *Cetraria islandica*.

The *Plagiothecium-Anastrepta* sub-community contains much heather and is very similar to *Calluna-Vaccinium-Sphagnum* heath H21. However, it has more *E. nigrum* ssp. *hermaphroditum*, *Vaccinium vitis-idaea*, *R. chamaemorus* and *C. suecica*, and the canopy of dwarf shrubs is shorter and more open. The mosses *Hylocomium splendens* and *Rhytidiadelphus loreus* are also generally more common in *Vaccinium-Rubus* heath, giving a rich golden tinge to the vegetation, but the rich assemblages of oceanic liverworts that distinguish the *Mastigophora-Herbertus* sub-community of *Calluna-Vaccinium-Sphagnum* heath H21b are absent. The grazed form of *Calluna-Vaccinium-Sphagnum* heath with little or no *Calluna* may resemble *Vaccinium-Rubus* heath, but has fewer pleurocarpous mosses and no montane species. The *Plagiothecium-Anastrepta* sub-community can also resemble *Calluna-Vaccinium* heath H12, but has more *Sphagnum capillifolium* and more of the northern species *E. nigrum* ssp. *hermaphroditum*, *Carex bigelowii*, *Vaccinium uliginosum*, *R. chamaemorus*, *C. suecica* and *Sphagnum fuscum*.

For the most part, the NVC defines *Calluna*-dominated heaths separately from *Vaccinium*-dominated heaths, so that vegetation co-dominated by both species can be understood quite clearly as being floristically intermediate. This pattern is confused by having one heathland community (*Vaccinium-Rubus* heath) that can be either dominated by *V. myrtillus* or co-dominated by *Calluna* and *V. myrtillus*. The *Vaccinium-Rubus* community appears to have been defined to include a heterogeneous range of heathland quadrat samples that contain one or both of *R. chamaemorus* and *C. suecica*. An alternative approach would be to include only the *Vaccinium*-dominated examples of the *Polytrichum-Galium* sub-community within the definition of

*Vaccinium-Rubus* heath, leaving the remainder of the vegetation currently assigned to this community to be regarded as a form of *Calluna-Vaccinium-Sphagnum* heath containing scattered plants of *R. chamaemorus* and *C. suecica*. Apart from *Vaccinium-Rubus* heath, all upland heathland NVC types are defined by their dwarf shrubs and bryophyte or lichen carpets: the species that make up the bulk of the vegetation. For the *Vaccinium-Rubus* heath to follow suit, *R. chamaemorus* and *C. suecica* should not be important defining species, and the community should include *Vaccinium* heaths that lack *R. chamaemorus* or *C. suecica*, but have pleurocarpous mosses, *Sphagnum capillifolium*, and montane species, such as *E. nigrum* ssp. *hermaphroditum* and *V. uliginosum*.

#### ECOLOGY

This is a montane community of moist, acid, peaty soils on damp slopes above 400 m. In the north-west and especially in the eastern Highlands it can be extensive on slopes of almost any aspect, as long as there is a moderately deep layer of peat or humus. Towards the south-eastern part of its range the community becomes increasingly restricted to shady slopes facing north or east (McVean and Ratcliffe 1962). Another habitat is around the edges of stands of *Calluna-Eriophorum* blanket bog M19, where the slope begins to get steeper and *Vaccinium-Rubus* heath forms a transitional zone between the bog and *Calluna-Vaccinium* heath.

*Vaccinium-Rubus* heath is evidently a near-natural climax community, maintained by low temperatures or late-lying snow. The *Polytrichum-Galium* sub-community occurs on shaded slopes and in sheltered hollows where a mildly prolonged cover of snow suppresses *Calluna* in favour of *V. myrtillus*. The *Plagiothecium-Anastrepta* sub-community is less associated with long-lying snow and is co-dominated by *Calluna*.

#### DISTRIBUTION

*Vaccinium-Rubus* heath is widely distributed in the Highlands with outliers in the Southern Uplands, Cheviots and north Wales (A B G Averis, pers. obs.). In the milder Hebrides and south-western Highlands it is generally replaced by the more oceanic *Calluna-Vaccinium-Sphagnum* heath. The geographical ranges of the two heaths overlap and both can occur on the same hill.

There is similar vegetation to *Vaccinium-Rubus* heath in western Norway.

## 1.5. Mesotrophic grassland communities (MG2-3, MG5, MG8, MG10)

### ***Arrhenatherum elatius-Filipendula ulmaria* tall-herb grassland (MG2)**

#### DESCRIPTION

This is a lush, species-rich grassland in which large grasses, such as *Arrhenatherum elatius*, *Dactylis glomerata* and *Festuca rubra*, form a rank, tussocky sward. They are interspersed with tall forbs, such as *Angelica sylvestris*, *Filipendula ulmaria* and *Valeriana officinalis*, and woodland species, including *Mercurialis perennis*, *Dryopteris filix-mas*, *Silene dioica* and *Heracleum sphondylium*. There may be a profuse underlay of mosses including *Plagiothecium denticulatum*, *Plagiomnium undulatum*, *Eurhynchium hians* and *Lophocolea bidentata*.

Two sub-communities are described in the NVC, but they are rather poorly separated. This is partly because of biased sampling in the NVC, which has focused on the habitat of the rare *Polemonium caeruleum*. The *Filipendula ulmaria* sub-community MG2a has more *Angelica sylvestris* and *Trisetum flavescens*. The *Polemonium caeruleum* sub-community MG2b has *P. caeruleum*, more *Festuca rubra*, and a few lowland species, such as *Stellaria holostea*, *Geranium robertianum*, *Scabiosa columbaria* and *Galium aparine*.

#### DIFFERENTIATION FROM OTHER COMMUNITIES

*Arrhenatherum-Filipendula* tall-herb grassland can be confused with the *Filipendula ulmaria* sub-community of *Arrhenatherum elatius* grassland MG1c, but it is more species-rich and has more woodland species, such as *Mercurialis perennis*, *Silene dioica*, *Stellaria holostea* and *Oxalis acetosella*. It might also be confused with *Filipendula-Angelica* tall-herb fen M27, which is a wetter community with more *Filipendula ulmaria*, fewer grasses and fewer woodland species. Flushed forms of *Festuca-Agrostis-Galium* grassland U4 with *F. ulmaria* and other mesotrophic forbs can bear some resemblance to *Arrhenatherum-Filipendula* grassland, but the swards are shorter, have less *Arrhenatherum* and *Dactylis glomerata*, and more mosses typical of acid grassland, such as *Rhytidiadelphus squarrosus* and *Hylocomium splendens*.

#### ECOLOGY

*Arrhenatherum-Filipendula* grassland occurs on steep, lightly grazed or ungrazed, rocky slopes, usually where there is some shade. The most characteristic habitat is near the margins of woodland. Soils are damp, base-rich rendzinas, derived mainly from calcareous rocks, such as limestone. This sub-montane type of vegetation has been found mainly between 200 m and 400 m, but occurs just above sea-level in western Scotland.

#### DISTRIBUTION

This is a scarce community recorded mainly in northern England on the Carboniferous limestone of Derbyshire and the Craven Pennines, but also known from the Cheviot, south-east Scotland and Mull.

There is similar vegetation in mainland Europe.

### ***Anthoxanthum odoratum-Geranium sylvaticum* grassland (MG3)**

#### DESCRIPTION

The thick swards of this grassland are generally made up of mixtures of the grasses *Anthoxanthum odoratum*, *Agrostis capillaris*, *Festuca rubra*, *Holcus lanatus*, *Poa trivialis*, *Dactylis glomerata* and *Cynosurus cristatus*. They are densely crowded with large, vigorous forbs, such as *Geranium sylvaticum*, *Plantago lanceolata*, *Conopodium majus*, *Rumex acetosa*, *Ranunculus acris*, *R. bulbosus*, *Alchemilla glabra* and *Sanguisorba officinalis*. The sward can reach a height of 60-80 cm by midsummer. Under the tall plants there may be smaller species such as *Cerastium fontanum*, *Trifolium repens* and *Bellis perennis*. Bryophytes can grow in dense wefts among the grasses; the commonest species are usually *Rhytidiadelphus squarrosus*, *Brachythecium rutabulum* and *Eurhynchium praelongum*.

There are three sub-communities. The *Bromus hordeaceus* ssp. *hordeaceus* sub-community MG3a is the most species-poor form, containing few forbs but with much *Bromus hordeaceus* ssp. *hordeaceus* and *Lolium perenne*. The *Briza media* sub-community MG3b is the most species-rich form, with *Rhinanthus minor*, *Trifolium pratense*, *Lotus corniculatus*, *Hypochaeris radicata*, *Centaurea nigra*, *Briza media*, *Luzula campestris* and other herbs. The *Arrhenatherum elatius* sub-community MG3c has a tall sward with much *Arrhenatherum elatius*, *Dactylis glomerata* and *Helictotrichon pubescens*.

## DIFFERENTIATION FROM OTHER COMMUNITIES

The flora of *Anthoxanthum-Geranium* grassland is generally similar to that of *Cynosurus-Centaurea* grassland MG5. The main difference between these two communities is that *Geranium sylvaticum*, *Geum rivale*, *Trollius europaeus*, *Cirsium heterophyllum* and *Alchemilla* species are commoner in *Anthoxanthum-Geranium* grassland.

The tall swards of the *Arrhenatherum* sub-community can resemble *Arrhenatherum elatius* grassland MG1 and *Arrhenatherum-Filipendula* grassland MG2, but differ in that they contain *G. sylvaticum* and *S. officinalis*. This sub-community might equally well have been placed within the NVC as a *Geranium sylvaticum-Sanguisorba officinalis* sub-community of *Arrhenatherum* grassland.

Some herb-rich examples of *Festuca-Agrostis-Galium* grassland U4 can look very like *Anthoxanthum-Geranium* grassland, but are generally mossier, and have more *Potentilla erecta* and *Galium saxatile*. Northern flushed forms of *Festuca-Agrostis-Galium* grassland, with species including *Filipendula ulmaria* in the west or *Helianthemum nummularium* and *Persicaria vivipara* in the east, can have *G. sylvaticum*, but are mossier than *Anthoxanthum-Geranium* grassland, have more *P. erecta*, and lack *S. officinalis*. The *Lathyrus-Stachys* sub-community U4c can contain *S. officinalis*, but also has *P. erecta*, *G. saxatile* and *Stachys officinalis*, and lacks *G. sylvaticum*. Stands transitional between the two communities occur locally, for example on hay-meadow banks in northern England (Richard Jefferson, pers. comm.).

## ECOLOGY

*Anthoxanthum-Geranium* grassland generally occurs on moist brown earth soils in enclosed farmland on level to sloping ground at around 200-400 m. It is usually grazed by sheep or cattle in autumn, winter and early spring before being shut up for hay in May. The tall hay crop is mown in late summer, after which the subsequent young growth (aftermath) may be grazed. The community also occurs on lightly grazed or mown roadside verges and on river banks.

## DISTRIBUTION

*Anthoxanthum-Geranium* grassland is a scarce community that is most common in upland valleys in the mid to north Pennines. It also occurs less commonly in the Lake District, the Southern Uplands, and the eastern and southern Highlands, where there are patches of it along roadside verges and on river banks.

There is similar vegetation on the Faroes (Hobbs and Averis 1991b) and in mainland Europe.

## ***Cynosurus cristatus-Centaurea nigra* grassland (MG5)**

### DESCRIPTION

This herb-rich pasture or meadow grassland has a dense and lush sward that is bright with flowers in summer. The bulk of the sward is composed of the grasses *Cynosurus cristatus*, *Festuca rubra*, *Agrostis capillaris*, *Holcus lanatus*, *Anthoxanthum odoratum* and *Dactylis glomerata*. The grasses are entwined with forbs, such as *Plantago lanceolata*, *Trifolium repens*, *T. pratense*, *Lotus corniculatus*, *Ranunculus acris*, *R. bulbosus*, *Prunella vulgaris*, *Rumex acetosa*, *Centaurea nigra*, *Taraxacum officinale* agg., *Rhinanthus minor*, *Euphrasia officinalis* and *Hypochaeris radicata*. There is little space for bryophytes in the dense turf, but there is usually at least some *Brachythecium rutabulum*, *Scleropodium purum*, *Eurhynchium praelongum* and *Rhytidiadelphus squarrosus*.

There are three sub-communities. The *Lathyrus pratensis* sub-community MG5a has *Lolium perenne*, *Bellis perennis* and *Lathyrus pratensis*. The *Galium verum* sub-community MG5b tends to occur on more base-rich soils, and includes plants such as *Galium verum*, *Trisetum flavescens*, *Carex flacca*, *Sanguisorba minor* and *Koeleria macrantha*, but of these species only *G. verum* is common in upland stands of *Cynosurus-Centaurea* grassland. The *Danthonia decumbens* sub-community MG5c has *Danthonia decumbens*, *Potentilla erecta* and *Succisa pratensis*.

## DIFFERENTIATION FROM OTHER COMMUNITIES

The swards of forbs and grasses in *Cynosurus-Centaurea* grassland resemble those of several other grassland types. *Arrhenatherum elatius* grassland MG1 has a coarser sward with more *Arrhenatherum* and *Heracleum sphondylium*, and less *Cynosurus cristatus*. *Arrhenatherum-Filipendula* grassland MG2 also comprises tall swards with much *Arrhenatherum*, and is further distinguished by woodland plants, such as *Mercurialis perennis*, *Urtica dioica*, *Dryopteris filix-mas* and *Silene dioica*, and species of damper soils, such as *Geum rivale* and *Filipendula ulmaria*. *Anthoxanthum-Geranium* grassland MG3 has many similarities with *Cynosurus-Centaurea* grassland, but has *Geranium sylvaticum* and *Alchemilla* species. Species-poor forms of *Cynosurus-*

*Centaurea* grassland can resemble *Lolium perenne*-*Cynosurus cristatus* grassland MG6, but *Lolium perenne* is generally not dominant, and *Centaurea nigra* and *Lotus corniculatus* are commoner.

The *Lathyrus-Stachys* sub-community of *Festuca-Agrostis-Galium* grassland U4c can look very like *Cynosurus-Centaurea* grassland, but has more *Galium saxatile* and *Potentilla erecta*, and more mosses, whereas *Cynosurus cristatus* and tall mesotrophic forbs are less common. *Festuca-Agrostis-Thymus* grassland CG10 has less *C. cristatus* and other mesotrophic species, and much *Thymus polytrichus*. Grasslands dominated by *Festuca rubra* and *Holcus lanatus* are quite common at low altitudes in some upland areas, such as the western Highlands (Cooper and MacKintosh 1996; Rodwell *et al.* 1998), but are not described in the NVC. They can resemble lush forms of *Cynosurus-Centaurea* grassland but have less *C. cristatus* and are generally less herb-rich.

#### ECOLOGY

This is a managed grassland of low-lying, well-drained, neutral mineral soils. It is maintained by manuring, grazing and cutting for hay. In upland Britain it occurs mainly within enclosed fields, but also along some unenclosed coastlines in the western Highlands and the Inner Hebrides. It is mostly below 300 m, and in the western Highlands is rare above 100 m.

#### DISTRIBUTION

*Cynosurus-Centaurea* grassland is widespread at low altitudes throughout Britain. Most examples of the community in upland Britain belong to the *Danthonia* sub-community, but the other two sub-communities also occur on the upland fringes.

There is similar vegetation in Ireland but nothing comparable has been described from mainland Europe.

### ***Cynosurus cristatus-Caltha palustris* grassland (MG8)**

#### DESCRIPTION

This is a herb-rich community in which the most common plant is usually *Caltha palustris*, its masses of bright yellow flowers forming eye-catching sheets in late spring and early summer. The *Caltha* is set within a green matrix of grasses including *Anthoxanthum odoratum*, *Holcus lanatus*, *Festuca rubra* and smaller quantities of *Agrostis capillaris*, *A. stolonifera*, *Poa trivialis*, *Alopecurus pratensis*, *A. geniculatus* and *Lolium perenne*; *Cynosurus cristatus* is very common in English stands, but scarcer in Scottish examples. Tucked into the deep, lush sward are forbs such as *Ranunculus acris*, *R. repens*, *Rumex acetosa*, *Trifolium repens*, *T. pratense*, *Rhinanthus minor*, *Filipendula ulmaria*, *Cardamine pratensis* and *Montia fontana*. In some examples of *Cynosurus-Caltha* grassland in northern England the sward is enriched with a few northern or upland species, such as *Trollius europaeus*, *Crepis paludosa*, *Geum rivale* and *Dactylorhiza purpurella*. There can be much *Carex nigra*; *Juncus acutiflorus* is common in English stands, but its place is taken by *J. articulatus* in northern Scotland. Bryophytes are very sparse in English examples of the community, where the commonest species are the mosses *Calliergonella cuspidata* and *Climacium dendroides*, but are more common and diverse in Scotland, where typical species include the mosses *C. cuspidata*, *Brachythecium rivulare*, *B. rutabulum*, *Eurhynchium praelongum* and *Plagiomnium undulatum*, and the liverworts *Chiloscyphus polyanthos* and *Pellia epiphylla*.

#### DIFFERENTIATION FROM OTHER COMMUNITIES

There is more *Caltha palustris* in *Cynosurus-Caltha* grassland than in any other vegetation type in upland Britain. *Caltha* can be very common in *Juncus-Galium* rush-pasture M23, *Molinia-Crepis* mire M26, *Filipendula-Angelica* fen M27 and *Iris-Filipendula* mire M28, but these communities are dominated by rushes, *Molinia caerulea*, *Filipendula ulmaria* or *Iris pseudacorus*.

*Cynosurus-Caltha* grassland shares many species with *Cynosurus-Centaurea* grassland MG5, but has more *Caltha*, *Ranunculus repens* and *F. ulmaria*. These species, and also the scarcity of *Geranium sylvaticum*, distinguish the community from *Anthoxanthum-Geranium* grassland MG3.

#### ECOLOGY

Most *Cynosurus-Caltha* grassland in the uplands occurs as small patches within enclosed hay-meadows or pastures, where it marks out more or less permanently wet, flushed mineral or organic soils on fairly level to gently sloping ground. This is rather different from the community's typical lowland habitat of periodically inundated ground, such as water meadows.

In the north Pennines, the community typically occurs among *Anthoxanthum-Geranium* and *Cynosurus-Centaurea* grasslands, *Juncus-Galium* rush-pastures, and *Molinia-Crepis* mires in valley-side hay-meadows, ascending to over 400 m. At higher altitudes it can be more extensive, covering entire fields. In Scotland it occurs in enclosed farmland at low altitudes, forming varied mosaics with vegetation types, such as *Cynosurus-Centaurea* grassland, *Lolium perenne-Cynosurus cristatus* grassland MG6, *Juncus-Galium* rush-pasture and *Iris-Filipendula* mire. Here it can also be associated with mixed swards of *Agrostis stolonifera*, *Carex nigra*, *Holcus lanatus*, *Anthoxanthum odoratum*, *Ranunculus repens* and *Rumex acetosa*. These grassy or sedgy swards are not described in the NVC, but are among the *Carex nigra-Agrostis stolonifera-Senecio aquaticus* grasslands (*Senecio-Brometum racemosi*) discussed by Rodwell *et al.* (1998).

#### DISTRIBUTION

Rodwell (1992) describes *Cynosurus-Caltha* grassland from widely scattered places in lowland Britain but does not mention it as an upland vegetation type. However, some of the NVC samples seem to have been recorded in upland pastures, as the floristic tables include *Trollius europaeus*, *Geum rivale* and *Crepis paludosa*. The vegetation described here as an upland form of *Cynosurus-Caltha* grassland has been found since the NVC analysis. It is a scarce vegetation type, which occurs in some of the north Pennine valleys, especially Upper Teesdale (Prosser 1990a, 1990b; Richard Jefferson, pers. comm.), and in widely scattered places in the Highlands, the Hebrides and Shetland (Roper-Lindsay and Say 1986; Cooper and MacKintosh 1996; Ben and Alison Averis, pers. obs.). Rodwell (1992) did not provide a map showing the distribution of the NVC samples for *Cynosurus-Caltha* grassland; consequently, lowland English records of the community are not shown on our map.

Vegetation similar to *Cynosurus-Caltha* grassland occurs in Germany and the Netherlands (Rodwell 1992), and is widespread in hay-meadows and ditches in the Faroe Islands (Hobbs and Averis 1991a).

### ***Holcus lanatus-Juncus effusus* rush-pasture (MG10)**

#### DESCRIPTION

This is damp grassland in which tussocks of *Juncus effusus* stand out in species-poor swards of *Holcus lanatus*, *Agrostis stolonifera*, *Poa trivialis*, *Ranunculus repens* and *R. acris*. These plants are interleaved with smaller species, such as *Cardamine pratensis* and *Trifolium repens*. The rushes are generally taller than the matrix of grasses and forbs, unless the community is heavily grazed. Bryophytes, such as *Eurhynchium praelongum*, *Brachythecium rutabulum*, *Calliergonella cuspidata* and *Rhytidiadelphus squarrosus*, grow in thin wefts over the damp soil and among the larger plants.

There are three sub-communities. The Typical sub-community MG10a has no distinguishing species of its own. The *Juncus inflexus* sub-community MG10b has more *J. inflexus* than *J. effusus*. The *Iris pseudacorus* sub-community MG10c has *Iris pseudacorus* and in some stands *Alopecurus pratensis*, *Phalaris arundinacea*, *Glyceria fluitans*, *Filipendula ulmaria* and *Lotus uliginosus*.

There is also a form of species-poor vegetation consisting of large tussocks of *J. effusus*, beneath which is a sward of typical acid grassland species, including *Agrostis capillaris*, *Festuca ovina*, *Anthoxanthum odoratum*, *Nardus stricta*, *Galium saxatile*, *Potentilla erecta* and the moss *Rhytidiadelphus squarrosus*. This does not fit clearly into any NVC type.

#### DIFFERENTIATION FROM OTHER COMMUNITIES

The *Juncus inflexus* sub-community of *Holcus-Juncus* rush-pasture is the only type of vegetation described in the NVC in which *J. inflexus* is dominant or co-dominant with *J. effusus*. The other two sub-communities can be confused with the *Juncus effusus* sub-community of *Juncus-Galium* rush-pasture M23b, but this is usually rather more species-rich, with more *Galium palustre*, *Cirsium palustre* and *Ranunculus flammula*, and generally with more bryophytes. The *Juncus effusus* sub-community of *Carex echinata-Sphagnum* mire M6c is dominated by *J. effusus* but has *Sphagna* and *Polytrichum commune*.

#### ECOLOGY

This is a vegetation type of damp acid to neutral soils on level to gently sloping ground in enclosed pastures and in neglected situations, such as ditches, pond sides and roadside verges. Most stands are at low altitudes, but the community extends to just over 300 m on the fringes of the uplands.

#### DISTRIBUTION

*Holcus-Juncus* rush-pasture is widespread in lowland Britain. It also occurs at low altitudes in most upland areas, although it is rare in the north-west Highlands, Lewis, Harris, Skye, Orkney and Shetland. Most of the records in the uplands are of the Typical sub-community. The other two sub-communities are more restricted to the lowlands. The *Juncus inflexus* sub-community is recorded mostly from the southern and eastern lowlands, but also occurs on upland limestone in the Craven and northern Pennines. The *Iris* sub-community has been recorded in Wales and south-west England.

There is vegetation similar to *Holcus-Juncus* rush-pasture in mainland Europe.

## 1.6. Calcicolous grassland communities (CG9-14)

### *Sesleria caerulea*-*Galium sternerii* grassland (CG9)

#### DESCRIPTION

*Sesleria-Galium* grasslands form extensive pale swards, broken by bone-white tracts of limestone, across the bold isolated hills of the Craven Pennines and over the strange stony moorlands of Upper Teesdale. These species-rich grasslands have a tufted sward of the tough, glaucous leaves of *Sesleria caerulea*. *Koeleria macrantha* and *Festuca ovina* are common here too, and there is much *Briza media* in some stands. *Thymus polytrichus* and *Helianthemum nummularium* trail among the grasses, and there is a rich array of other small herbs, such as *Galium sternerii*, *Linum catharticum*, *Viola riviniana* and *Carex flacca*. There is usually some *Ctenidium molluscum*. The turf can be dense, or sparse and thin.

There are five sub-communities. The *Helianthemum oelandicum*-*Asperula cynanchica* sub-community CG9a is a lowland grassland that usually occurs as fragmented patches over rocky ground and on cliff ledges. Characteristic species include *Helianthemum oelandicum*, *Hippocrepis comosa*, *Scabiosa columbaria*, *Asperula cynanchica*, *Carlina vulgaris* and *Anthyllis vulneraria*. The Typical sub-community CG9b has no distinguishing species other than those which define the community as a whole; there is usually less *H. nummularium* and more *Hypnum cupressiforme* s.l. and *Dicranum scoparium*. It can form continuous swards or more open vegetation on stony ground. The *Carex pulicaris*-*Carex panicea* sub-community CG9c is a damp upland grassland characterised by the two sedges, *Potentilla erecta*, *Polygala vulgaris*, *Hylocomium splendens*, *Frullania tamarisci* and *Coelocaulon aculeatum*. There are some records here too for *Parnassia palustris*, *Pinguicula vulgaris*, *Primula farinosa*, *Dryas octopetala*, *Carex hostiana* and *Pimpinella saxifraga*, and in some stands there are a few moorland plants, such as *Calluna vulgaris*, *Molinia caerulea* and *Empetrum nigrum*. The *Carex capillaris*-*Kobresia simpliciuscula* sub-community CG9d is a damp, sedgy upland grassland that resembles the *Carex pulicaris*-*Carex panicea* sub-community, but has a suite of rare montane calcicoles, including *Kobresia simpliciuscula*, *Gentiana verna* and *Carex capillaris*, as well as more widespread plants, such as *Selaginella selaginoides* and *Persicaria vivipara*. There can be thick mats of bryophytes, such as *Racomitrium ericoides*, *R. lanuginosum*, *Hylocomium splendens* and *Hypnum cupressiforme* s.l.. The *Saxifraga hypnoides*-*Cochlearia alpina* sub-community CG9e is also a damp grassland with *Carex pulicaris*. Here there is another array of scarce montane calcicoles, including *Myosotis alpestris* and *Draba incana*, together with *Saxifraga hypnoides*, *Cochlearia alpina* and *Plagiochila asplenioides*. The *Carex pulicaris*-*Carex panicea*, *Carex*-*Kobresia* and *Saxifraga*-*Cochlearia* sub-communities are similar in many ways. Each has a distinctive assemblage of species but in some stands many of the characteristic plants are rare or completely absent. Some vegetation can therefore be hard to assign to a sub-community.

Locally in Wales there are grasslands with swards of *Festuca ovina*, *Agrostis capillaris*, *Thymus polytrichus*, *Linum catharticum*, *Carex flacca*, *Galium sternerii* and *Sanguisorba minor*, and with scattered *Carlina vulgaris*, *Scabiosa columbaria*, *Carex panicea*, *Briza media* and *Thalictrum minus*. Despite the absence of *Sesleria caerulea*, this vegetation has some characteristics of *Sesleria-Galium* grassland. It also has affinities with *Festuca ovina*-*Carlina vulgaris* grassland CG1, *Festuca ovina*-*Helictotrichon pratense* grassland CG2 and *Festuca-Agrostis-Thymus* grassland CG10.

Given the fact that some calcicolous grasslands outside the peculiarly small British range of *Sesleria* have floras very similar to *Sesleria-Galium* grassland, the various forms of vegetation currently classified as this community could perhaps be regarded as variants of other more widespread grassland types. The *Helianthemum-Asperula* sub-community could be seen as a *Sesleria* form of *Festuca-Carlina* grassland, the Typical sub-community as a *Sesleria* form of *Festuca-Helictotrichon* grassland, and the *Carex pulicaris*-*Carex panicea*, *Carex*-*Kobresia* and *Saxifraga-Cochlearia* sub-communities as a *Sesleria* form of the *Saxifraga-Ditrichum* sub-community of *Festuca-Agrostis-Thymus* grassland. The lowland *Sesleria albicans*-*Scabiosa columbaria* grassland CG8 could be reclassified in a similar way.

#### DIFFERENTIATION FROM OTHER COMMUNITIES

The dominance of *Sesleria* separates *Sesleria-Galium* grassland from all other British plant communities except *Sesleria-Scabiosa* grassland. These two *Sesleria* grasslands are very similar. However, *Galium sternerii* is more characteristic of *Sesleria-Galium* grassland, and *Carex panicea* and *C. pulicaris* are common in the damper, more strongly upland sub-communities; these species are all scarce in *Sesleria-Scabiosa* grassland. Conversely, the predominantly lowland species *Plantago media*, *Galium verum*, *Primula veris*, *Leontodon hispidus* and *Sanguisorba minor* are more common in *Sesleria-Scabiosa* grassland.

Stands of the *Carex pulicaris-Carex panicea* sub-community containing much *Dryas octopetala* can be quite similar to *Dryas-Silene* heath CG14 which, however, has more montane species, such as *Silene acaulis*, *Saxifraga aizoides*, *S. oppositifolia* and *Alchemilla alpina*. The damper *Sesleria-Galium* grasslands can be confused with *Carex-Pinguicula* mire M10. *Sesleria* can grow in *Carex-Pinguicula* flushes, and both communities provide habitats for rare montane calcicoles, such as *Kobresia simpliciuscula* and *Carex capillaris*, and also for the uncommon *Primula farinosa*. *Sesleria-Galium* grasslands have a denser sward, with *Galium sternerii*, *Helianthemum nummularium* and lichens, such as *Coelocaulon aculeatum* and *Cetraria islandica*, whereas *Carex-Pinguicula* mires are more open, with *Carex dioica*, *Juncus articulatus*, *Triglochin palustris*, *Drepanocladus revolvens*, *Bryum pseudotriquetrum*, *Campylopusium stellatum* and other species of wet ground.

#### ECOLOGY

*Sesleria-Galium* grassland is almost entirely confined to thin, calcareous, free-draining but moist rendzina soils over drift-free exposures of Carboniferous limestone. It clothes steep slopes below outcrops of limestone, and is also common on cliff ledges, in stable scree, on river shingle and among limestone pavements. The *Carex-Kobresia* sub-community is especially associated with gravelly granular exposures of metamorphosed sugar limestone. The *Helianthemum-Asperula* and *Carex-Kobresia* sub-communities cover thin soils that can become totally parched in summer, and many of the plants that grow in the *Helianthemum-Asperula* sub-community are resistant to drought.

*Sesleria-Galium* grassland comprises both lowland and upland types of vegetation, and has an altitudinal range from near sea-level to over 700 m. The *Helianthemum-Asperula* sub-community has a lowland distribution, the Typical sub-community occurs in both upland and lowland situations, and the *Carex pulicaris-Carex panicea*, *Carex-Kobresia* and *Saxifraga-Cochlearia* sub-communities are exclusively upland. High-altitude stands of *Sesleria-Galium* grassland are probably near-natural. In the harsh upland climate the soils are unstable because of physical and chemical weathering, and although they are highly calcareous they are not rich in plant nutrients. This means that the smaller rare species, such as *Viola rupestris*, *Carex capillaris* and *Gentiana verna*, are able to flourish because there is not much competition from more vigorous plants.

The soils are derived from limestone and can be rich in lead and other heavy metals. Metallophyte species, such as *Minuartia verna* and the lichens *Bacidia bagliettoana*, *B. sabuletorum*, *Cladonia pocillum*, *Collema tenax*, *Diploschistes muscorum*, *Leptogium teretiusculum*, *Peltigera rufescens*, *Polyblastia gelatinosa* and *Veizdaea aestivalis*, can be quite common in *Sesleria-Galium* grassland (Gilbert 2000).

#### DISTRIBUTION

*Sesleria-Galium* grassland is confined to exposures of Carboniferous limestone in northern England around Morecambe Bay, on the Orton Fells, on the Appleby Fells, in Upper Teesdale, and in the Craven Pennines of Yorkshire. The *Helianthemum-Asperula* sub-community is confined to the west, occurring in places close to the sea and on limestone scars at the eastern edge of the Lake District. The Typical, *Carex pulicaris-Carex panicea* and *Saxifraga-Cochlearia* sub-communities are widely distributed across the Craven Pennines of north Yorkshire, around Malham and Wharfedale, and around Settle and Wharfedale. The *Carex-Kobresia* sub-community is known only from Upper Teesdale. There is vegetation similar to *Sesleria-Galium* grassland but without *Sesleria caerulea* on some Carboniferous limestone hills in Wales (see above).

Vegetation almost identical to *Sesleria-Galium* grassland occurs on Carboniferous limestone in western and north-western Ireland (most notably on the Burren), and there are similar grasslands in mainland Europe.

### ***Festuca ovina-Agrostis capillaris-Thymus polytrichus* grassland (CG10)**

#### DESCRIPTION

This is a grassland with a short, green species-rich turf. The grassy matrix of *Festuca ovina*, *F. rubra*, *Agrostis capillaris*, *Anthoxanthum odoratum*, *Potentilla erecta* and *Viola riviniana* is entangled with the creeping stems of the tiny shrub *Thymus polytrichus*; its dark leaves are fragrant underfoot and its purple-pink flowers are conspicuous in summer. *Festuca vivipara* is common in many Scottish stands. The small mesotrophic forbs *Prunella vulgaris*, *Plantago lanceolata*, *Ranunculus acris* and *Achillea millefolium* are scattered through the sward, and bryophytes are common, especially the large, red-gold moss *Hylocomium splendens*.

Three sub-communities are described in the NVC. The *Trifolium repens-Luzula campestris* sub-community CG10a is most common at low to moderate altitudes and on drier soils. It contains much *Anthoxanthum*, *Trifolium repens*, *Galium saxatile*, *Luzula campestris* and *Rhytidadelphus squarrosus*. There are few sedges in the sward except for some *Carex caryophyllea* and *C. pilulifera*. The *Carex pulicaris-Carex panicea* sub-

community CG10b occurs on damper soils. It has a greyer, more sedgy sward than the *Trifolium-Luzula* sub-community, with *Carex panicea*, *C. pulicaris*, *C. flacca* and *Linum catharticum*. *Agrostis canina* can be as common as *A. capillaris*, and in some stands there is a little *Succisa pratensis* and *Selaginella selaginoides*. The *Saxifraga aizoides-Ditrichum flexicaule* sub-community CG10c is the most northern and montane form. It is a grassland of damp soils, and has the characteristic species of the *Carex pulicaris-Carex panicea* sub-community together with an array of small montane herbs, such as *Saxifraga aizoides*, *S. oppositifolia*, *Persicaria vivipara*, *Thalictrum alpinum* and *Carex capillaris*, and the calcicole mosses *Ctenidium molluscum*, *Tortella tortuosa*, *Ditrichum flexicaule s.l.* and *Hypnum lacunosum*. In many stands in the Breadalbanes the grass sward of this sub-community is composed mainly of *Festuca ovina*, *Briza media* and *Helictotrichon pratense*, with only a little *Anthoxanthum* and *Agrostis* species, and, rarely, *Sesleria caerulea*. Elsewhere, *Festuca ovina*, *Anthoxanthum* and *Agrostis* species are the most common grasses.

#### DIFFERENTIATION FROM OTHER COMMUNITIES

*Festuca-Agrostis-Thymus* grassland can be confused with several other short upland grassland communities. It is more species-rich than either *Festuca-Agrostis-Rumex* grassland U1 or *Festuca-Agrostis-Galium* grassland U4. *Thymus polytrichus* is common and there are more small herbs, such as *Prunella vulgaris*, *Ranunculus acris* and *Lotus corniculatus*, whereas the acid grasslands have more *Galium saxatile* and generally have a more continuous underlayer of mosses. *Sesleria-Galium* grassland CG9 differs from *Festuca-Agrostis-Thymus* grassland in being dominated by *Sesleria*. *Festuca-Agrostis-Alchemilla* grassland CG11 is distinguished by having much more *Alchemilla alpina*. *Festuca-Alchemilla-Silene* dwarf-herb vegetation CG12 has *Silene acaulis* as well as *A. alpina*, and the turf is more herb-dominated than in *Festuca-Agrostis-Thymus* grassland.

Around the fringes of some Carboniferous limestone hills in Wales, *Festuca-Agrostis-Thymus* grassland can grade into the predominantly lowland *Festuca ovina-Helictotrichon pratense* grassland CG2. *Helictotrichon pratense*, *H. pubescens*, *Briza media*, *Koeleria macrantha*, *Helianthemum nummularium*, and lowland forbs, such as *Sanguisorba minor*, *Scabiosa columbaria* and *Carlina vulgaris*, are more common in *Festuca-Helictotrichon* grassland, whereas the characteristic upland grassland species *Agrostis capillaris*, *Anthoxanthum* and *Potentilla erecta* are scarce.

As noted above, there is marked variation in the composition of the grass swards of the *Saxifraga-Ditrichum* sub-community. This sub-community straddles an important division within British calcicolous grasslands. In the cool, wet climate of the north and west, where soils tend not to be strongly base-rich because of leaching, there are swards of *Festuca ovina*, *F. vivipara*, *Agrostis* species and *Anthoxanthum* with many small forbs and sedges. In the NVC these are accommodated within the *Festuca-Agrostis-Thymus*, *Festuca-Agrostis-Alchemilla* and *Festuca-Alchemilla-Silene* communities. In contrast, in strongly basic habitats in the warmer and drier south and east (but penetrating into cold upland environments in the north Pennines and the Breadalbanes, where the soils are very base-rich), there are grasslands of *F. ovina*, *Briza media*, *Helictotrichon pratense*, *Koeleria macrantha* and, more locally, *Sesleria*. These mostly belong to the *Festuca ovina-Carlina vulgaris* CG1, *Festuca-Helictotrichon* CG2, *Festuca ovina-Pilosella officinarum-Thymus polytrichus/pulegioides* grassland CG7, *Sesleria caerulea-Scabiosa columbaria* CG8, and *Sesleria-Galium* CG9 grassland communities. Some forms of the *Saxifraga-Ditrichum* sub-community of *Festuca-Agrostis-Thymus* grassland belong in the first group of calcicolous grasslands whereas others belong in the second group.

#### ECOLOGY

*Festuca-Agrostis-Thymus* grassland is a community of shallow, brown, silty soils with a pH between 5.3 and 7.2 (McVean and Ratcliffe 1962). The base-status of the soils is maintained either by physical and chemical weathering or by irrigation with base-rich water. *Festuca-Agrostis-Thymus* grassland can clothe large tracts of ground where basic rocks predominate, but can also mark out intrusions of basic rocks or flushed areas in places where the rocks are generally acid. It occurs on a wide range of slopes and aspects. Most stands are in the sub-montane zone below about 700 m, but it can occur at altitudes of over 1000 m.

#### DISTRIBUTION

*Festuca-Agrostis-Thymus* grassland is widespread in the British uplands but is not recorded in south-west England or the North York Moors, and is very rare in the southern Pennines. It is especially common on the Dalradian schist of the Breadalbane hills, and there are notably large stands on Mull, in Morvern, and on the Trotternish ridge of Skye.

Vegetation related to *Festuca-Agrostis-Thymus* grassland occurs in mainland Europe.

## ***Festuca ovina*-*Agrostis capillaris*-*Alchemilla alpina* grass-heath (CG11)**

### DESCRIPTION

In this grassland type, a short, species-rich, loosely-woven, silvery sward of *Alchemilla alpina*, *Festuca vivipara*, *Anthoxanthum odoratum* and *Agrostis capillaris* forms the background for many small flowering plants, such as *Ranunculus acris*, *Persicaria vivipara*, *Thymus polytrichus*, *Thalictrum alpinum* and *Carex pulicaris*. The herbs are entwined with mosses, in particular the red-gold *Hylocomium splendens* and *Rhytidiadelphus loreus*, and the large, grey-green *Racomitrium lanuginosum*.

There are two sub-communities. Stands on drier soils with *Viola riviniana*, *Rhytidiadelphus squarrosus*, *Pleurozium schreberi* and *Dicranum scoparium* belong to the Typical sub-community CG11a. In the damper *Carex pulicaris*-*Carex panicea* sub-community CG11b, *Carex pulicaris* and *C. panicea* are common, together with other plants of damp habitats, such as *Selaginella selaginoides*, *Pinguicula vulgaris* and *Viola palustris*.

### DIFFERENTIATION FROM OTHER COMMUNITIES

*Festuca*-*Agrostis*-*Alchemilla* grass-heath resembles *Festuca*-*Agrostis*-*Thymus* grassland CG10 but has much more *Alchemilla alpina*. It is also similar to the *Festuca*-*Alchemilla*-*Silene* dwarf-herb community CG12 but lacks the large mats of *Silene acaulis* that are characteristic of that vegetation type, and has less *Deschampsia cespitosa*.

The community might be confused with a distinctive mossy form of the *Vaccinium*-*Deschampsia* sub-community of *Festuca*-*Agrostis*-*Galium* grassland U4e in which there is a thin sward of grasses and *Alchemilla alpina* growing through a silvery carpet of *Racomitrium lanuginosum*. However, this form of *Festuca*-*Agrostis*-*Galium* grassland is relatively species-poor, and calcicolous species, such as *Thymus polytrichus*, are very rare or absent; *Vaccinium myrtillus* and *Deschampsia flexuosa* occur in some stands. The floristic table for *Festuca*-*Agrostis*-*Alchemilla* grass-heath in the NVC suggests that *V. myrtillus* is common here, but bilberry is a plant of acid habitats and is not characteristic of calcicolous grasslands. It seems possible that the NVC data might include some quadrat samples recorded in vegetation that would be better classed as the *Alchemilla alpina* form of the *Vaccinium*-*Deschampsia* sub-community of *Festuca*-*Agrostis*-*Galium* grassland.

### ECOLOGY

Most stands of *Festuca*-*Agrostis*-*Alchemilla* grass-heath are on high slopes (generally over 600 m and extending to over 1000 m) on moderately basic shallow soils that are flushed but free-draining. The community occurs on slopes of all aspects and on a variety of gradients. Many stands are small, possibly because there is so much leaching at these high altitudes that there are few large spreads of suitably basic soils.

### DISTRIBUTION

*Festuca*-*Agrostis*-*Alchemilla* grass-heath is widespread but scarce throughout the Highlands. It is common on the basic Dalradian rocks of the Breadalbanes, the Durness limestone, and basic exposures of the Moine Schist. There are outlying stands on basalt hills in Morvern, on the Ardmeanach in Mull, on the Trotternish ridge on Skye, and on Borrowdale Volcanic rocks in the Lake District.

There is similar vegetation in mainland Europe and on the Faroes.

## ***Festuca ovina*-*Alchemilla alpina*-*Silene acaulis* dwarf-herb community (CG12)**

### DESCRIPTION

These short velvety-green swards of *Silene acaulis* and *Minuartia sedoides*, spiked through with a little *Festuca vivipara*, *Deschampsia cespitosa* and *Anthoxanthum odoratum*, are bright in summer with the pink flowers of *S. acaulis*. They enclose a splendid array of dwarf herbs: *Alchemilla alpina*, *A. glabra*, *Persicaria vivipara*, *Thalictrum alpinum*, *Saxifraga oppositifolia*, *Selaginella selaginoides*, *Luzula spicata*, *Sibbaldia procumbens*, *Carex capillaris*, *Trollius europaeus* and *Geum rivale*. Calcicolous mosses, such as *Hypnum lacunosum* and *Ctenidium molluscum*, grow through the carpets of vascular plants.

### DIFFERENTIATION FROM OTHER COMMUNITIES

This is a distinctive community. It could be confused with some examples of *Festuca*-*Agrostis*-*Thymus* grassland CG10 or *Festuca*-*Agrostis*-*Alchemilla* grassland CG11, but has more *Silene acaulis*, and generally

more forbs and fewer grasses, than either of these communities. It has a similar flora to the *Dryas-Silene* ledge community CG14, but *Dryas octopetala* is much more common in the *Dryas-Silene* community.

Some stands of the *Festuca-Alchemilla-Silene* dwarf-herb community resemble the *Silene* sub-community of *Carex-Racomitrium* moss-heath U10c, but they have more *Agrostis capillaris* and *Deschampsia cespitosa*, and less *Racomitrium lanuginosum* and *Carex bigelowii*. The community shares some species with the *Silene-Luzula* sub-community of *Salix-Racomitrium* snow-bed U12a, including *Silene acaulis*, *Luzula spicata*, *Thymus polytrichus* and *Persicaria vivipara*, but in the snow-bed these species are set in a matrix of diminutive liverworts and montane mosses, rather than forming a thick, continuous, green sward.

#### ECOLOGY

The *Festuca-Alchemilla-Silene* dwarf-herb community occurs on calcareous and damp but free-draining soils at high altitudes: generally above 600 m and extending up above 1000 m. At these altitudes many stands are covered with snow for much of the winter. The community can occur at the foot of cliffs where many of the small herbs must have seeded down from plants on the ungrazed ledges. It occurs on all aspects and a range of gradients.

#### DISTRIBUTION

This type of vegetation occurs throughout the Scottish Highlands, and there is an outlier in north Wales. In the Hebrides it has been recorded only on Mull, Skye and Rum. The largest stands are on the calcareous mica-schist of the Breadalbane hills, especially on Ben Lui and Ben Lawers.

There is similar vegetation on the Faroe Islands (Hobbs and Averis 1991a) and in Norway.

### ***Dryas octopetala-Carex flacca* heath (CG13)**

#### DESCRIPTION

In this community, the small, dark-green, shining leaves of *Dryas octopetala* grow in a tight, low mat over the ground, and the plant is only conspicuous in summer when the large pale-cream delicate flowers unfold. The mat of *Dryas* is interlaced with *Thymus polytrichus*, and pricked through by *Carex flacca*, *C. panicea*, *Viola riviniana*, *Plantago maritima*, *P. lanceolata*, *Linum catharticum* and *Festuca ovina*. Under the vascular plants there are tufts and patches of the mosses *Hylocomium splendens*, *Fissidens dubius*, *Hypnum cupressiforme* s.l. and, on the rocks that break through the thin skin of soil, *Neckera crispa*, *Ctenidium molluscum* and *Tortella tortuosa*.

There are two sub-communities: one grassy and one heathy. The grassy form is the *Pilosella officinarum-Ctenidium molluscum* sub-community CG13a, which has an especially rich array of species, including *Pilosella officinarum*, *Potentilla erecta*, *Carex pulicaris*, *C. caryophyllea*, *Prunella vulgaris*, *Bellis perennis* and *Ctenidium molluscum*; there can be short, stunted shoots of *Calluna vulgaris*. The *Salix repens-Empetrum nigrum* ssp. *nigrum* sub-community CG13b includes more heathy vegetation. The canopy of shrubs is usually a little taller and denser here, and *Dryas* is joined by *Arctostaphylos uva-ursi*, *Salix repens* (including ssp. *argentea*), *Empetrum nigrum* (both ssp. *nigrum* and ssp. *hermaphroditum*), *Erica cinerea* and, in some stands, *Juniperus communis* ssp. *nana*. There are also a few mosses, such as *Scleropodium purum* and *Rhytidiadelphus triquetrus*, growing over the ground in loose wefts.

#### DIFFERENTIATION FROM OTHER COMMUNITIES

*Dryas-Carex* heath can be confused with its montane counterpart, *Dryas-Silene* heath CG14. *Dryas-Silene* heath has more montane species, such as *Silene acaulis*, *Saxifraga aizoides*, *S. oppositifolia*, *Carex capillaris*, *Alchemilla alpina*, *Oxyria digyna*, *Saussurea alpina*, *Thalictrum alpinum* and *Polystichum lonchitis*; *Sedum rosea*, *Trollius europaeus*, *Geum rivale*, *Geranium sylvaticum* and other tall forbs occur in many stands. Lowland plants, such as *Bellis perennis*, *Koeleria macrantha*, *Plantago lanceolata* and *Carex flacca*, are more common in *Dryas-Carex* heath. The main habitats of the two are also quite different. *Dryas-Carex* heath occurs mainly in grazed mosaics of heath and grassland at low altitudes, whereas *Dryas-Silene* heath is a community of ungrazed cliff ledges at higher altitudes.

*Dryas* can be common in the *Carex pulicaris-Carex panicea* sub-community of *Sesleria-Galium* grassland CG9c, but that vegetation differs clearly from *Dryas-Carex* heath in being dominated by *Sesleria albicans*.

#### ECOLOGY

*Dryas-Carex* heath occurs on shallow calcareous rendzinas and skeletal soils over Durness limestone and dolomite, Dalradian limestone, Jurassic limestone and, in a few places, basalt. The soils are damp but free-draining, and are base-rich, either with calcium or magnesium; the pH can be as high as 7.5. The community occurs around limestone pavements, below cliffs and on screes, and also on exposed headlands where calcareous shell-sand has been blown inland over peaty soils. Stands vary in size from a few hectares to patches only a few metres across. It is a sub-montane vegetation type, occurring from just above sea-level along the north coast of Scotland and on Skye to over 430 m in Wester Ross, although most stands are below 100 m. *Dryas* grows slowly and can only compete with other, more vigorous plants in northern Scotland where the climate is cool, moist and oceanic and the growing season is short.

#### DISTRIBUTION

In Britain, *Dryas-Carex* heath is confined to the maritime fringes of the north-west Highlands. It extends eastwards along the north coast of Scotland from Durness to Invernaver. From Durness southwards to Inchnadamph, Rassal and Kishorn and onto Skye it follows the outcrops of Durness limestone and dolomite along the Moine Thrust Plane. It also occurs on Jurassic limestone on Raasay, on Dalradian limestone on Lismore, and on Tertiary basalt on Skye and Rum.

Similar forms of *Dryas* heath, though with fewer arctic-alpine species, occur at low altitudes on the Burren in western Ireland. In Scandinavia and other parts of mainland Europe *Dryas octopetala* is more common in montane vegetation.

### ***Dryas octopetala-Silene acaulis* ledge community (CG14)**

#### DESCRIPTION

These are spreading loose mats of *Dryas octopetala*; its dark-green and silver scallop-edged leaves are decorated with delicate creamy flowers in summer. The low canopy of *Dryas* is interspersed with bright-green cushions of *Silene acaulis* and darker green trailing stems of *Thymus polytrichus*, *Saxifraga aizoides* and *S. oppositifolia*, and is pierced by the neat dark leaves of *Persicaria vivipara* and the pale shoots of *Selaginella selaginoides*. There is generally also an array of taller species, such as *Geum rivale*, *Sedum rosea*, *Rubus saxatilis*, *Geranium sylvaticum*, *Ranunculus acris*, *Trollius europaeus* and *Polystichum lonchitis*, and montane willows may occur. There is a deep underlay of bryophytes, comprised of *Ctenidium molluscum*, *Tortella tortuosa*, *Ditrichum flexicaule* s.l., *Orthothecium rufescens*, *Neckera crispa* and other calcicolous mosses and liverworts.

#### DIFFERENTIATION FROM OTHER COMMUNITIES

*Dryas-Silene* ledge vegetation might be confused with *Dryas-Carex* heath CG13, but it occurs in quite different situations, and montane species, such as *Silene acaulis*, *Carex capillaris*, *Saxifraga oppositifolia* and *Thalictrum alpinum*, are more common. *Dryas* can grow in the *Carex pulicaris-Carex panicea* sub-community of *Sesleria-Galium* grassland CG9c, but this is a grassy sward dominated by *Sesleria caerulea*. *Dryas* can also grow in the *Luzula-Geum* tall-herb community U17 but it never forms such extensive mats there as it does in the *Dryas-Silene* ledge community.

#### ECOLOGY

This community is confined to calcareous rock ledges with free-draining, base-rich soils; most stands are between 300 m and 900 m. The soils are rendzina-like or moist loams and are irrigated by base-rich water from calcareous parent rocks. Solifluction, freeze-thaw and dry flushing help to keep the soils immature and base-rich with a high pH (McVean and Ratcliffe 1962). *Dryas-Silene* vegetation occurs in places that are either inaccessible or only lightly grazed, including cliff ledges, steep rocky slopes with broken crags, and among boulders. Some stands are on exposed south-facing slopes and are dry in summer.

#### DISTRIBUTION

The *Dryas-Silene* community is most common on Dalradian mica-schist in the Breadalbane region of Scotland between Ben Lui and Caenlochan. It also occurs in the western and north-western Highlands and the Hebrides, on Durness limestone, basic Moine rocks, basalt and other volcanic outcrops. There are fragmentary outliers in north Wales.

There are similar forms of *Dryas* vegetation in Scandinavia.

## 1.7. Calcifugous grasslands and montane communities (U1-U21)

### ***Festuca ovina*-*Agrostis capillaris*-*Rumex acetosella* grassland (U1)**

#### DESCRIPTION

This is a low, tufted patchy sward of the grasses *Festuca ovina*, *Aira praecox* and *Agrostis capillaris*, sprinkled with *Rumex acetosella*. There is a patchy cover of bryophytes over the thin dry soil, comprising the mosses *Pleurozium schreberi*, *Dicranum scoparium*, *Brachythecium albicans*, *Polytrichum formosum*, *P. juniperinum* and *P. piliferum*, and in some places the liverwort *Ptilidium ciliare* with its distinctive, yellow-gold, fringed leaves. Some stands are scattered with low-grown, heavily-browsed bushes of *Ulex gallii* or *U. europaeus*. In many lowland stands there is a distinctive assemblage of annual herbs, but these occur only rarely in the uplands. Although the turf is green in winter it soon dries out in spring and early summer to a pale silver-grey sward.

*Festuca*-*Agrostis*-*Rumex* grassland is predominantly a lowland community but at least two of the six sub-communities also occur in the uplands. The *Galium saxatile*-*Potentilla erecta* sub-community U1e is defined by *Galium saxatile*, *Potentilla erecta* and *Deschampsia flexuosa*. The *Hypochaeris radicata* sub-community U1f has *Hypochaeris radicata*, *Leontodon autumnalis*, *Sedum anglicum* and *Festuca rubra*. Some stands on steep dry rocky slopes in eastern Wales and central Scotland have ephemeral species, such as *Aphanes arvensis* and *Erophila verna*, and can be moderately herb-rich. These show some affinity to the *Erodium cicutarium*-*Teesdalia nudicaulis* sub-community U1c.

#### DIFFERENTIATION FROM OTHER COMMUNITIES

In the uplands this community is likely to be confused only with *Festuca*-*Agrostis*-*Galium* grassland U4. *Festuca*-*Agrostis*-*Rumex* grassland has a sparser sward in which plants of open ground, such as *Rumex acetosella*, *Pilosella officinarum* and *Senecio jacobaea*, are common. *Festuca*-*Agrostis*-*Galium* grassland has more *Anthoxanthum odoratum*, *Holcus lanatus* and *Viola riviniana* within a more continuous and mossy sward.

#### ECOLOGY

*Festuca*-*Agrostis*-*Rumex* grassland occurs on thin, dry acid soils. In the uplands it is most common on south-facing rocky slopes and rocky knolls at low altitudes, and rarely occurs above 400 m. The underlying rocks are generally hard and acid: granite and Old Red Sandstone in south-west England, and Cambrian, Pre-Cambrian, Ordovician, Silurian and Devonian sedimentary and igneous rocks extending from Wales to central Scotland.

#### DISTRIBUTION

*Festuca*-*Agrostis*-*Rumex* grassland is widespread in lowland Britain, and extends locally into upland areas. The *Galium*-*Potentilla* sub-community is the commonest form in the uplands, and occurs in scattered localities from south-west England to eastern Scotland. It accounts for much of the grassland vegetation on some of the Shropshire hills. The *Hypochaeris* sub-community is much scarcer in the uplands but has been recorded in the hills of mid Wales (Woods 1993). Stands showing affinities with the *Erodium*-*Teesdalia* sub-community are known from eastern Wales and eastern Scotland.

Related forms of grassland occur throughout central Europe as far east as Poland, and also locally in southern and central Scandinavia.

### ***Deschampsia flexuosa* grassland (U2)**

#### DESCRIPTION

This is a tussocky grassland dominated by fine-leaved, dark-green clumps of *Deschampsia flexuosa*. The smooth rounded tufts of this plant can give the sward a characteristic quilted appearance, and the tall, delicate, silvery-pink panicles of flowers are conspicuous in summer. There can be a small amount of *Calluna vulgaris* among the *D. flexuosa*.

There are two sub-communities. The grassy *Festuca ovina*-*Agrostis capillaris* sub-community U2a includes common plants of upland acid grassland, such as *Festuca ovina*, *Agrostis capillaris*, *Potentilla erecta* and *Galium saxatile*. *Pteridium aquilinum* grows in many stands. The sparse mat of bryophytes includes the mosses *Polytrichum piliferum* and *Dicranum scoparium*. The heathy *Vaccinium myrtillus* sub-community U2b has a freckling of *Vaccinium myrtillus* and, less commonly, *Empetrum nigrum*, *Molinia caerulea*, *Eriophorum vaginatum*, *Juncus squarrosus*, *J. effusus* and *Agrostis canina*. *Calluna* is generally commoner here than in the *Festuca*-*Agrostis* sub-community, and the sparse flora of mosses is augmented by *Pleurozium schreberi*, *Polytrichum commune* and *Hypnum jutlandicum*.

#### DIFFERENTIATION FROM OTHER COMMUNITIES

*Deschampsia* grassland may be confused with grassy stands of *Calluna-Deschampsia* heath H9 or *Vaccinium-Deschampsia* heath H18, but *Deschampsia flexuosa* is dominant rather than subordinate to dwarf shrubs as it is in heathland vegetation.

In a few high corries of the Cairngorms there are snow-beds dominated by *Deschampsia flexuosa*, with a montane flora very different from that of *Deschampsia* grassland, including *Juncus trifidus*, *Huperzia selago* and the mosses *Polytrichum alpinum* and *Dicranum fuscescens*. These are a distinctive form of *Salix-Racomitrium* snow-bed U12 (Rodwell *et al.* 1998).

#### ECOLOGY

*Deschampsia* grassland is typical of slopes and valley sides with base-poor, moist, free-draining soils. It is a lowland to sub-montane vegetation type, and rarely, if ever, occurs above 600 m. In many places this community represents the first stage of recolonising vegetation within felled conifer plantations where it forms an untidy grassland among the dead stumps and branches of the felled trees. It can also replace blanket bog vegetation where the peat has dried out as a result of excessive burning.

#### DISTRIBUTION

The community is widespread around the upland margins from Devon to the eastern Highlands, and also occurs in some lowland areas. The *Vaccinium* sub-community is the most common form of *Deschampsia* grassland in the uplands. It does not seem to have been recorded in mainland Europe.

### ***Agrostis curtisii* grassland (U3)**

#### DESCRIPTION

From a distance this grassland looks similar to *Festuca-Agrostis-Galium* grassland U4, but here the sward is dominated by the dense, wiry, glaucous tufts of *Agrostis curtisii*. The turf has a blue-grey tinge that is visible from some distance, and is usually short, tightly-grazed and species-poor. Associated species include *Agrostis capillaris*, *Festuca ovina*, *Danthonia decumbens*, *Calluna vulgaris*, *Potentilla erecta*, *Galium saxatile* and *Molinia caerulea*. There is no more than a thin and patchy layer of bryophytes comprising species, such as *Dicranum scoparium*, *Pleurozium schreberi*, *Hypnum jutlandicum*, *Rhytidiadelphus squarrosus* and *Scleropodium purum*.

#### DIFFERENTIATION FROM OTHER COMMUNITIES

*Agrostis* grassland is the only British grassland community dominated by *Agrostis curtisii*. It bears a superficial resemblance to *Deschampsia* grassland U2 because *A. curtisii* and *Deschampsia flexuosa* are rather similar in growth-form, though not in colour.

#### ECOLOGY

This is one of the most widespread grassland communities in the uplands of south-west England, where it forms mosaics with *Festuca-Agrostis-Galium* grassland and *Ulex gallii-Agrostis* heath H4. It occurs on gentle slopes on moist free-draining acidic soils (Rodwell 1992). It is a community of lower ground, up to about 500 m.

#### DISTRIBUTION

The distribution of the community is limited by that of *Agrostis curtisii*. It is recorded in south-west England, Dorset, Hampshire, the Isle of Wight, and on Old Castle Down, Mynydd y Gaer and Mynydd Llangeinwyr in south Wales. There are particularly large stands on the grazed commons of Bodmin Moor.

There are similar *Agrostis curtisii* grasslands in western France.

### ***Festuca ovina-Agrostis capillaris-Galium saxatile* grassland (U4)**

#### DESCRIPTION

These grasslands are usually short and tightly grazed, and vary in colour from dull, grey-green or pale ochre-green to a brighter rich green that can stand out clearly from the sombre tones of other upland vegetation. The dense turfs of *Festuca ovina*, *Agrostis capillaris* and *Anthoxanthum odoratum* are trailed through by *Galium saxatile* and *Potentilla erecta*. There is usually a thick mat of mosses around the vascular plants, in which *Rhytidiadelphus squarrosus* is one of the most common species.

There are five sub-communities. The Typical sub-community U4a has no distinguishing species of its own. In many places the species-poor sward is thick with mosses: *Hylocomium splendens*, *Rhytidiadelphus loreus*, *Pleurozium schreberi* and *Hypnum jutlandicum* grow in rich golden-green mats and patches. *Potentilla erecta* and *Galium saxatile* are very common here, colouring the turf with their yellow and white flowers in summer. The *Holcus lanatus*-*Trifolium repens* sub-community U4b has a less mossy sward and can include some species characteristic of more improved grasslands. For example, *Holcus lanatus*, *Trifolium repens*, *Achillea millefolium* and *Cerastium fontanum* are common, and the sward of *Festuca ovina*, *Agrostis capillaris* and *Anthoxanthum* can be augmented by *Cynosurus cristatus*, *Poa pratensis* and even *Lolium perenne* and *Dactylis glomerata*. The *Lathyrus linifolius*-*Stachys officinalis* sub-community U4c is distinguished by *Stachys officinalis*, *Galium verum*, *Helictotrichon pratensis* and *Lathyrus linifolius*. The *Luzula multiflora*-*Rhytidiadelphus loreus* sub-community U4d is a very mossy grassland in which *Agrostis canina* may be commoner than *A. capillaris*. Quite commonly there are clumps of *Luzula multiflora* and *Deschampsia cespitosa*, and scattered plants of damp-loving species, such as *Viola palustris* and *Carex panicea*. The dense richly-coloured mats and turfs of mosses include *Rhytidiadelphus loreus*, *Thuidium tamariscinum* and *Hylocomium splendens*. The *Vaccinium myrtillus*-*Deschampsia flexuosa* sub-community U4e is also a mossy grassland. Many stands have much *Vaccinium myrtillus* or *Racomitrium lanuginosum* or both, and *Deschampsia flexuosa* and *Nardus stricta* grow here too. These grasslands can have more *R. lanuginosum* than the NVC tables suggest, and in this form they can take the place of *Carex-Racomitrium* moss-heath U10 in Wales, the Lake District and southern Scotland.

There are other forms of *Festuca-Agrostis-Galium* grassland that are not described in the NVC. There is a sparse variant of the *Vaccinium-Deschampsia* sub-community comprising a thin sward of *Festuca vivipara* and *Agrostis canina* growing through a carpet of *Racomitrium lanuginosum* and *Alchemilla alpina* (e.g. Averis and Averis 1999a, 1999b). Other forms of the community resemble the *Vaccinium-Deschampsia* sub-community but have *Diphasiastrum alpinum* (which can be the dominant species), *Huperzia selago* and in some places *Lycopodium clavatum* (e.g. Averis and Averis 2000b). There are various herb-rich forms of *Festuca-Agrostis-Galium* grassland related to the *Lathyrus-Stachys* sub-community. For example, in northern England there are stands transitional between the *Lathyrus-Stachys* sub-community and the *Danthonia* sub-community of *Cynosurus-Centaurea* grassland MG5c, and also stands transitional to *Anthoxanthum-Geranium* grassland MG3 (Richard Jefferson, pers. comm.). Further north there is a type of grassland rather like the *Lathyrus-Stachys* sub-community but with little or no *Stachys officinalis*, and with much *Helianthemum nummularium* and some upland species, such as *Persicaria vivipara* (Averis 1999; Smith 2000). In the Highlands there is a herb-rich form of *Festuca-Agrostis-Galium* grassland with tall mesotrophic forbs, such as *Filipendula ulmaria*, *Ranunculus acris*, *Geum rivale*, *Alchemilla glabra*, *Parnassia palustris* and *Angelica sylvestris*, growing with the grasses, small forbs and mosses typical of the community (e.g. Averis and Averis 1998a, 1999a). In Wales and Scotland there is a form of *Festuca-Agrostis-Galium* grassland with much *Sphagnum capillifolium* and *S. denticulatum* that is apparently derived by grazing from *Calluna-Vaccinium-Sphagnum* damp heath H21 (Alex Turner, pers. comm.; A B G Averis and A M Averis, pers. obs.).

#### DIFFERENTIATION FROM OTHER COMMUNITIES

*Festuca-Agrostis-Galium* grassland and *Nardus-Galium* grassland U5 share a similar suite of species but can generally be distinguished by the relative amounts of the different grasses: *Festuca* species, *Agrostis* species and *Anthoxanthum* are more common than *Nardus* in *Festuca-Agrostis-Galium* grassland, whereas the converse is true of *Nardus-Galium* grassland. All forms of *Festuca-Agrostis-Galium* grassland can be separated from the similar *Festuca-Agrostis-Thymus* grassland CG10 by the scarcity or absence of *Thymus polytrichus*. In addition, *Galium saxatile* is more common and there are rarely any small calcicolous herbs in *Festuca-Agrostis-Galium* grassland. Some calcicoles do occur in the *Lathyrus-Stachys* sub-community, but this has *Stachys officinalis* and other herbs that are rare in *Festuca-Agrostis-Thymus* grassland.

The Typical sub-community might be confused with the *Potentilla-Galium* sub-community of *Festuca-Agrostis-Rumex* grassland U1e, but has more *Agrostis capillaris* and *Anthoxanthum*, and little or no *Rumex acetosella*.

Semi-improved stands of the *Holcus-Trifolium* sub-community can come close to *Lolium perenne-Cynosurus cristatus* grassland MG6, but have less *Lolium perenne*, *Cynosurus cristatus* and *Dactylis glomerata*, more *Potentilla erecta*, *Galium saxatile* and *Festuca ovina*, and thicker patches of mosses, such as *Rhytidiadelphus squarrosus*. Some forms of the *Holcus-Trifolium* sub-community contain *Centaurea nigra*, *Lotus corniculatus*, *Ranunculus acris* and other mesotrophic forbs, and could be confused with *Cynosurus-Centaurea* grassland MG5. *Cynosurus-Centaurea* grassland can usually be distinguished by the scarcity of *Festuca ovina* and *Galium saxatile*, and the greater quantity of *Cynosurus cristatus*.

The mossy *Luzula-Rhytidiadelphus* sub-community can resemble *Deschampsia-Galium* grassland U13. However, *Deschampsia-Galium* vegetation is a snow-bed grassland with less *Festuca ovina*, *Agrostis canina* and *Potentilla erecta*, and more montane species, such as *Carex bigelowii*, *Alchemilla alpina*, *Polytrichum alpinum* and *Cetraria islandica*.

Some forms of the *Vaccinium-Deschampsia* sub-community are very similar to the *Galium* sub-community of *Carex-Racomitrium* moss-heath U10a. Montane species, such as *Carex bigelowii*, *Diphasiastrum alpinum* and *Salix herbacea*, can persist in stands of *Festuca-Agrostis-Galium* grassland that have been derived from summit heath. *Carex-Racomitrium* heath generally has more *Racomitrium lanuginosum* and less *Agrostis capillaris*, *Nardus*, *Anthoxanthum*, *Festuca* species and *Rhytidiadelphus squarrosus*. The form of the *Vaccinium-Deschampsia* sub-community with *Alchemilla alpina* differs from the superficially similar *Festuca-Agrostis-Alchemilla* grassland CG11 in the absence of *Thymus polytrichus* and other small calcicoles.

#### ECOLOGY

This is a grassland of acid brown earths and brown podsollic soils that drain freely but can be moist. The Typical sub-community is the most common form. It clothes many hill slopes where the intensity of grazing is moderately high; smaller patches occur high up into the hills in matrices of heaths and bogs, under crags, on alluvial flats and fans, and around rock outcrops. The *Holcus-Trifolium* sub-community, with its more mesotrophic assemblage of species, tends to occur on deeper and richer soils at low altitudes; many stands have probably been limed in the past and some have been treated with fertiliser. The *Lathyrus-Stachys* sub-community occupies soils that appear to be slightly flushed, and are richer than those with the Typical sub-community. The flushed, herb-rich form of *Festuca-Agrostis-Galium* grassland with *Filipendula ulmaria* and other tall mesotrophic herbs occurs on moist soils on cool north-facing slopes in the Highlands. The *Luzula-Rhytidiadelphus* sub-community replaces the Typical sub-community at higher altitudes and on damper soils, and is particularly characteristic of concave slopes. The *Vaccinium-Deschampsia* sub-community covers thin stony soils on convex slopes and summits.

*Festuca-Agrostis-Galium* grasslands have a vast altitudinal range: the various sub-communities cover the whole spread of the uplands from near sea-level to over 1000 m. The community is most common in upland regions where the rocks are acid to at least moderately base-rich and where there has been a long history of grazing. It is rare over highly acid rocks, such as granite and quartzite.

#### DISTRIBUTION

There are *Festuca-Agrostis-Galium* grasslands throughout upland Britain from south-west England to Orkney and Shetland; they also occur in some parts of the lowlands. The Typical and *Holcus-Trifolium* sub-communities are common throughout the uplands. The *Lathyrus-Stachys* sub-community occurs mainly in England and Wales. Other herb-rich forms appear to be restricted to Scotland: the variant with *Helianthemum nummularium* is scattered in the Southern Uplands and the southern Highlands, and the form characterised by *Filipendula ulmaria* and other mesotrophic herbs has been found only in the western Highlands and the Hebrides. The *Luzula-Rhytidiadelphus* sub-community has a distinctly northern distribution. The *Vaccinium-Deschampsia* sub-community is also commonest in the north, but stands defined more by *Vaccinium myrtillus* than by *Racomitrium lanuginosum* are widespread in Wales; the form with *Alchemilla alpina* has been found in the Breadalbanes and on Mull and Skye.

There are similar forms of acid grassland in Ireland and also in mainland Europe.

### ***Nardus stricta-Galium saxatile* grassland (U5)**

#### DESCRIPTION

Pale swards of the dense, wiry, clumps of *Nardus stricta* clothe many upland slopes, and can form vast stands. Several other grasses can grow with the *Nardus*, the most common of which are *Agrostis capillaris* and *Festuca ovina*. The short turf is starred with *Potentilla erecta* and *Galium saxatile*, their flowers bright in summer. There is usually some *Vaccinium myrtillus*, its short, bright-green shoots pushing up through the mat of grasses. At the feet of the vascular plants there are the usual mosses of acid grassland: *Hypnum jutlandicum*, *Pleurozium schreberi*, *Rhytidiadelphus loreus*, *R. squarrosus* and *Hylocomium splendens*.

There are five sub-communities. The Species-poor sub-community U5a takes in the most impoverished *Nardus* grasslands and has no distinguishing species of its own. The *Agrostis canina-Polytrichum commune* sub-community U5b occurs on damper soils, and has *Agrostis canina*, *Luzula multiflora*, *Juncus squarrosus* and *Polytrichum commune*; various *Sphagna* are common in some stands. The *Carex panicea-Viola riviniana* sub-community U5c extends the range of the community onto flushed, mildly base-rich soils where there can be an

array of mesotrophic species, such as *Ranunculus acris*, *Alchemilla glabra*, *Thalictrum alpinum*, *Geum rivale*, *Filipendula ulmaria*, *Trollius europaeus* and *Persicaria vivipara*. The *Calluna vulgaris*-*Danthonia decumbens* sub-community U5d has a mixed sward of *Nardus*, *Festuca ovina*, *Agrostis capillaris*, *Anthoxanthum odoratum*, *Deschampsia flexuosa* and *Danthonia decumbens*, together with patches of short *Calluna vulgaris*, *Erica cinerea* and *E. tetralix*. The *Racomitrium lanuginosum* sub-community U5e has an extensive silvery carpet of *Racomitrium lanuginosum*; the sward of *Nardus* can be sparse, and may be interspersed with *Trichophorum cespitosum*, *Calluna* and, more locally, a few montane or northern species, such as *Diphasiastrum alpinum*, *Huperzia selago*, *Carex bigelowii* and *Vaccinium vitis-idaea*.

#### DIFFERENTIATION FROM OTHER COMMUNITIES

*Nardus-Carex* grass-heath U7 can be confused with sub-montane *Nardus-Galium* grassland, but it occurs in places where snow lies late, and has montane species, such as *Carex bigelowii*, *Alchemilla alpina*, *Diphasiastrum alpinum*, *Vaccinium uliginosum* and *Cetraria islandica*, that are uncommon in *Nardus-Galium* grassland. It can be particularly hard to separate the *Racomitrium* sub-community of *Nardus-Galium* grassland from the *Empetrum-Cetraria* sub-community of *Nardus-Carex* grass-heath, especially in the western Highlands where both are common and can occur in close association. The main difference is that the snow-bed grassland generally has a thicker sward of *Nardus* containing some *C. bigelowii* and other montane species.

*Nardus-Galium* grassland can be very similar to *Festuca-Agrostis-Galium* grassland U4 and *Juncus-Festuca* grassland U6. All three communities share a similar range of species, although the relative proportions differ and a few plants are more common in one type than in the others. Generally, *Nardus-Galium* grassland is the only one that is clearly dominated by *Nardus*.

The *Racomitrium* sub-community can be very heathy, with some resemblance to *Calluna-Racomitrium* heath H14 and to low and open forms of the *Cladonia* sub-community of *Trichophorum-Erica* wet heath M15c. *Nardus-Galium* grassland has more *Nardus* than either of the heath communities, less *Trichophorum cespitosum*, *Molinia caerulea* and *Erica tetralix* than the wet heath, and the heather is generally not as severely wind-pruned as it is in the montane *Calluna* heath.

#### ECOLOGY

*Nardus-Galium* grassland clothes damp acid mineral soils with peaty upper horizons, and can occur in very large stands on upland hillsides. It typically occupies slopes where the depth and wetness of the soil are intermediate between the drier podsoles under *Festuca-Agrostis-Galium* grasslands and the wet shallow peats under *Juncus-Festuca* grassland. The underlying rock can be anything from acid to basic, but the soils are generally acid with some podsolisation. The community can also occur on deep peat from which the original mire vegetation has been lost (e.g. through burning or drainage). Another typical habitat is well-drained but moist alluvial soil along the margins of streams, and it is quite common to see the pale sinuous lines of such grasslands cutting across areas of heath or bog.

This is a community of mid-altitude slopes, ranging from about 300 m to above 700 m, with the *Racomitrium* sub-community extending to over 850 m. Most stands are anthropogenic, but many examples of the *Racomitrium* sub-community at high altitudes are likely to be near-natural.

#### DISTRIBUTION

This community is ubiquitous throughout the British uplands, but is most common where there has been a long history of sheep grazing. Some of the largest stands are in the Breadalbane region of Scotland, the Southern Uplands, the Lake District and Wales. It is scarce in south-west England. Most of the sub-communities are widely distributed, but the *Racomitrium* sub-community occurs mainly in the cool oceanic north-west Highlands and Hebrides, and the *Carex-Viola* sub-community mainly in the Breadalbanes.

Vegetation similar to *Nardus-Galium* grassland occurs rarely in the west of mainland Europe.

### ***Juncus squarrosus-Festuca ovina* grassland (U6)**

#### DESCRIPTION

These deep-green, tussocky swards stand out clearly from the surrounding vegetation on hillsides and plateaux. The dense rosettes of *Juncus squarrosus* are entwined with trailing shoots of *Potentilla erecta* and *Galium saxatile*, and enmeshed with the mosses *Pleurozium schreberi*, *Polytrichum commune*, *Hylocomium splendens*, *Rhytidiadelphus squarrosus* and *R. loreus*.

Four sub-communities are described in the NVC, showing a general trend from wet to drier substrates. The *Sphagnum* species sub-community U6a occurs on deep wet peat, and the stiff leaves of the *Juncus* push through cushions and carpets of *Sphagnum fallax*, *S. capillifolium* and, in some places, *S. papillosum*. The *Carex nigra-Calypogeia azurea* sub-community U6b is defined by the mosses *Plagiothecium undulatum* and *Aulacomnium palustre*, and the uncommon liverwort *Calypogeia azurea*. The *Vaccinium myrtillus* sub-community U6c has a mixed sward of *J. squarrosus* and *Deschampsia flexuosa* with scattered sprigs of *Vaccinium myrtillus*; large pleurocarpous mosses, such as *Rhytidiadelphus loreus*, *Pleurozium schreberi* and *Hypnum jutlandicum*, are more common in this sub-community than in other forms of the community. The *Agrostis capillaris-Luzula multiflora* sub-community U6d is the grassiest form, and comprises variegated swards in which *Agrostis canina*, *Anthoxanthum odoratum*, *Deschampsia flexuosa*, *Nardus stricta* and *Festuca vivipara* either form discrete patches or grow in mixtures with *J. squarrosus*.

Across much of the geographical range of *Juncus-Festuca* grassland, variation within the community does not correspond closely to the four sub-communities described in the NVC. The *Sphagnum* sub-community is generally distinct, and the *Agrostis-Luzula* sub-community can be recognised without difficulty in many places. However, one of the most common types of *Juncus-Festuca* grassland on damp peaty soils is species-poor vegetation conforming to the description given above for the community as a whole. The nearest fit is with the *Carex-Calypogeia* or *Vaccinium* sub-communities but the vegetation cannot be assigned unequivocally to either of these. In addition, there are two distinctive forms of *Juncus-Festuca* grassland that are very different from any of the NVC sub-communities. One is a heathy form, usually resembling the *Sphagnum* sub-community but with much *Calluna vulgaris* or *Vaccinium myrtillus* (e.g. Averis and Averis 1999a, 2000b). The other is a flushed, species-rich form with mesotrophic herbs, such as *Ranunculus acris*, *Thalictrum alpinum*, *Trollius europaeus*, *Geum rivale*, *Alchemilla glabra*, *Crepis paludosa* and *Parnassia palustris* (McVean and Ratcliffe 1962; Birks and Ratcliffe 1980; Averis and Averis 1999a, 1999b).

#### DIFFERENTIATION FROM OTHER COMMUNITIES

*Juncus squarrosus* is common in some stands of *Nardus-Galium* grassland U5 and *Festuca-Agrostis-Galium* grassland U4, and both of these communities can blend gradually into the *Agrostis-Luzula* sub-community of *Juncus-Festuca* grassland. There is a thicker, more continuous sward of *J. squarrosus* in *Juncus-Festuca* grassland; the other communities are clearly dominated by their characteristic grasses. One could argue that the *Agrostis-Luzula* sub-community is simply an intermediate stage between *Juncus-Festuca* grassland and *Festuca-Agrostis-Galium* grassland, and that if it is worthy of recognition as a distinct vegetation type, then so are many other 'intermediates'.

The *Sphagnum* sub-community can resemble various types of bog vegetation, particularly the *Juncus-Rhytidiadelphus* sub-community of *Trichophorum-Eriophorum* blanket bog M17c, but bog species, such as *Eriophorum vaginatum*, *E. angustifolium*, *Trichophorum cespitosum*, *Erica tetralix* and *Narthecium ossifragum*, are sparse or absent.

#### ECOLOGY

This is a vegetation type of damp peaty soils or gleyed podsols on flat or gently-sloping ground. The soils are moist and can be waterlogged. The community is generally indifferent to underlying geology, but the scarce species-rich stands are associated with base-rich rocks, particularly the Dalradian schist and limestone of the central Highlands. Most stands occur between 400 m and 800 m (McVean and Ratcliffe 1962; Rodwell 1992).

There is an ecological gradient from *Festuca-Agrostis-Galium* grassland on mineral soils on steep free-draining hillsides, through *Nardus-Galium* grassland on moister, peat-topped soils on somewhat gentler slopes, to *Juncus-Festuca* grassland on wet, peaty plateaux and shallow slopes. Commonly, there is a parallel increase in altitude, so that *Juncus-Festuca* grasslands experience the coolest and wettest climate and have the shortest growing-season. This sequence can be seen very well on many hill slopes in the Lake District.

#### DISTRIBUTION

*Juncus-Festuca* grassland occurs throughout the north and west of Britain, but is scarce in south-west England, where it is confined to the higher parts of Dartmoor. It is especially common in upland areas with a long history of heavy grazing and frequent burning: Wales, northern England, the Southern Uplands and the southern Highlands. Stands tend to be smaller in the north-west Highlands.

Species-poor *Juncus squarrosus* grasslands appear to be confined to the uplands of Britain and Ireland. Similar grasslands occur very locally in south-west Norway and in some more southern parts of western mainland Europe, but these European grasslands tend to be floristically richer than our *Juncus-Festuca* vegetation (Rodwell

1992). On the Faroes there are *Juncus squarrosus* blanket bogs with some resemblance to *Juncus-Festuca* grassland (Hobbs and Averis 1991a).

### ***Nardus stricta*-*Carex bigelowii* grass-heath (U7)**

#### DESCRIPTION

These pale patches of *Nardus stricta* grassland form distinct and usually clean-edged stands on steep high slopes, in gullies and hollows, and in shaded corries. The dense, short, tufted sward of *Nardus* is set with small montane species, such as *Carex bigelowii*, *Diphasiastrum alpinum*, *Polytrichum alpinum* and *Cetraria islandica*. The turf is pressed flat by the weight of winter snow and is saturated by melt-water in spring and early summer; it looks dull and bedraggled, and in spring is usually a tawny-brown colour until the new leaves of *Nardus* start to grow.

There are three sub-communities. The *Empetrum nigrum* ssp. *hermaphroditum*-*Cetraria islandica* sub-community U7a characteristically has *Trichophorum cespitosum*, *Juncus squarrosus*, *Vaccinium uliginosum*, and, in some places, a few oceanic liverworts, such as *Anastrophyllum donnianum* and *Pleurozia purpurea*. *Trichophorum* can be co-dominant with *Nardus* here, and *Racomitrium lanuginosum* may also be very common. The Typical sub-community U7b has no particular distinguishing species and includes stands that do not fit either of the other two sub-communities. The *Alchemilla alpina*-*Festuca ovina* sub-community U7c has a more mixed sward including *Festuca ovina*, *Agrostis canina*, *Carex pilulifera* and *Alchemilla alpina*.

#### DIFFERENTIATION FROM OTHER COMMUNITIES

*Nardus*-*Carex* grass-heath is most readily confused with sub-montane *Nardus-Galium* grassland U5, but has more montane plants, such as *Carex bigelowii*, *Polytrichum alpinum* and *Cetraria islandica*. Forms of the *Empetrum-Cetraria* sub-community co-dominated by *Nardus* and *Trichophorum* can have some resemblance to *Trichophorum-Erica* wet heath M15, but have more *Nardus* and montane species, and lack *Erica tetralix*, *Calluna vulgaris* and *Molinia caerulea*.

#### ECOLOGY

This is a montane grassland of medium to high altitudes; most stands lie above 500 m. It marks out places where snow lies moderately late in spring. Winter snow is redistributed by the wind, swirling into hollows on the high plateaux, and being blown off the edges of plateaux and high ridges to build up into deep drifts on the slopes below, where it fills hollows, chokes gullies, and lies thickly on the floors of shaded corries. Because the prevailing strong winds are from the west and south-west, snow accumulates on the northern and eastern sides of the hills. These slopes are also the most shaded; where they are very steep they may not receive any direct sunlight during the winter. The growing season is short and cool. Most commonly the soils are peats or humic gravels, and even where the underlying rocks are basic there is so much leaching that the substrate is generally acid and wet.

#### DISTRIBUTION

*Nardus*-*Carex* grass-heath occurs in the uplands from north Wales and the Lake District northwards to Orkney and Shetland; it is most common and extensive in the Scottish Highlands. In the north-west, there are particularly big stands in corries that hold moderately late snow, and there are good examples on Ben More Assynt, the Fannich Hills, Beinn Eighe and in the Inverlael Forest.

Similar vegetation occurs in western Scandinavia and the Faroes. The more oceanic form of the *Empetrum-Cetraria* sub-community, with much *Racomitrium lanuginosum* and oceanic liverworts, is apparently restricted to Scotland and the Faroe Islands.

### ***Carex bigelowii*-*Polytrichum alpinum* sedge-heath (U8)**

#### DESCRIPTION

In late-lying snow-beds at high altitudes, the montane sedge *Carex bigelowii* grows in a spiky, grey-green sward over a velvety dark green turf of the mosses *Polytrichum alpinum* or *Dicranum fuscescens* or both. The ground is scattered with lichens; the most common species are *Cladonia arbuscula* and the montane *Cetraria islandica*. This vegetation type is a species-poor assemblage in which few other plants play a part.

There are two sub-communities. The *Polytrichum alpinum*-*Ptilidium ciliare* sub-community U8a has a thick turf of *C. bigelowii* growing through a layer of *Polytrichum alpinum* that is variegated with other species such as *Dicranum scoparium*, the liverwort *Ptilidium ciliare*, and the lichens *Cladonia pyxidata* and *Cetraria delisei*. The

*Dicranum fuscescens-Racomitrium lanuginosum* sub-community U8b has a sparser turf of *C. bigelowii*, and *P. alpinum* tends to occur as scattered tufts in a carpet of *Dicranum fuscescens*. The sward is more varied than in the *Polytrichum-Ptilidium* sub-community, with much *Racomitrium lanuginosum* and species such as *Festuca vivipara*, *Agrostis capillaris* and *Vaccinium myrtillus*. Many stands of *Carex-Polytrichum* sedge-heath, especially in the west, have few of the species that distinguish either form of the community, and cannot therefore be assigned clearly to a sub-community.

#### DIFFERENTIATION FROM OTHER COMMUNITIES

These sedge-heaths comprise dense swards of *Carex bigelowii* and mosses, and are usually sharply-defined from other communities on the ground. They can be confused only with other montane vegetation types in which *C. bigelowii* is common. *Nardus-Carex* grass-heath U7 has more *Nardus stricta*, and less *Polytrichum alpinum* and *Dicranum fuscescens*. *Carex-Racomitrium* moss-heath U10 has more *Racomitrium lanuginosum*, and less *P. alpinum*. The *Rhytidiadelphus* sub-community of *Deschampsia-Galium* grassland U13b can be distinguished by the deep mats of the mosses *Rhytidiadelphus loreus* and *Hylocomium splendens*.

#### ECOLOGY

*Carex-Polytrichum* sedge-heath is a community of late-lying snow-beds at high altitudes, usually above 850 m. It is most typical of those parts of the Highlands where there is a cold montane climate with much of the winter precipitation falling as snow. It occurs on the acid Cairngorm granite, and on the Moine and Dalradian rocks of the central Highlands. The soils are usually podsolised shallow peats with a pH between 3.6 and 4.4 (McVean and Ratcliffe 1962). Drainage is impeded and the substrate is wet, often being irrigated by melting snow. The community occupies a rather similar ecological niche to the *Rhytidiadelphus* sub-community of *Deschampsia-Galium* grassland, but it is more dependent on snow-cover. It occurs most commonly on ground that is level or at most only slightly sloping, and stands can be large where there is deep snow throughout the winter. It is also common around the margins of bryophyte-dominated snow-beds belonging to the *Polytrichum-Kiaeria* U11 and *Salix-Racomitrium* U12 communities (McVean and Ratcliffe 1962; Rodwell 1992).

#### DISTRIBUTION

*Carex-Polytrichum* sedge-heath is one of the more northern, continental types of upland vegetation in Britain and is more common in the east than in the west. It occurs on the higher hills in the central and eastern Highlands of Scotland, from Ben Lui and the Cowal Peninsula in the south to Ben Wyvis and the Fannich Hills in the north. There are particularly impressive examples on the highest plateaux of the Cairngorms and Lochnagar, on the hills around the head of Caenlochan Glen, on Creag Meagaidh, and on the summit of Ben Wyvis. Very similar vegetation, but lacking the more exacting montane lichens, occurs on high slopes just below ridges and plateaux on Carnedd Llewelyn, Y Wyddfa (Snowdon) and Crib y Ddysgl in north Wales (A M Averis and A Turner pers. obs.).

Similar snow-bed heaths occur locally in Norway and Sweden.

#### CONSERVATION INTEREST

Like other forms of snow-bed, *Carex-Polytrichum* sedge-heath is of high value for nature conservation. It is a rare community in Britain, and forms an important link with the vegetation of mountains in mainland Europe. The uncommon *Luzula spicata* and *Cetraria delisei* occur in some stands.

#### MANAGEMENT

This is a near-natural plant community that is not usually affected by management. It may be threatened by a warmer climate with less snow. The lichen flora of stands on popular hills could be damaged by human trampling and by the use of all-terrain vehicles on the high ground.

### ***Juncus trifidus-Racomitrium lanuginosum* rush-heath (U9)**

#### DESCRIPTION

The most striking plant in these montane heaths is the small, slender rush *Juncus trifidus*, which grows in sparse swards, circular clumps or scattered thin turfs on bare stony plateaux. The clumps of rush are typically interleaved with a little *Carex bigelowii* and can have an understorey of *Racomitrium lanuginosum*. The *J. trifidus* leaves are bright shining green in their vigorous phase of growth in early spring, but by midsummer the shoot tips begin to turn orange, and in the autumn the vegetation is tinged a conspicuous rich russet.

There are two sub-communities: one lichen-rich and one more mossy. The *Cladonia arbuscula-Cetraria islandica* sub-community U9a has lichens, such as *Cladonia arbuscula*, *C. uncialis* ssp. *biuncialis*, *C. bellidiflora*, *C. gracilis*, *Ochrolechia frigida*, *Stereocaulon saxatile* and *Cetraria islandica*. Very open stands of *J. trifidus* belong in this sub-community. The *Salix herbacea* sub-community U9b takes in thicker turfs in which the sedges and rushes are joined by *Vaccinium myrtillus*, *Salix herbacea* and *Galium saxatile*; this sub-community is not as lichen-rich as the *Cladonia-Cetraria* sub-community.

#### DIFFERENTIATION FROM OTHER COMMUNITIES

The *Salix* sub-community of *Juncus-Racomitrium* rush-heath can be confused with various forms of *Carex-Racomitrium* moss-heath U10. It can usually be easily distinguished from the *Galium* and Typical sub-communities U10a and U10b, as *Juncus trifidus* and *Salix herbacea* are much more common, and *Festuca vivipara*, *Deschampsia flexuosa* and *Galium saxatile* are scarce. However, there are much greater similarities to the *Silene* sub-community U10c. This sub-community encompasses a wide range of vegetation, including herb-rich swards with many small calcicoles, slightly less rich examples with a scattering of herbs within a mossy carpet, and sparse open stands of mosses and herbs on wind-scoured ground. These variants all have much *J. trifidus* and *S. herbacea*; they can be distinguished from the *Salix* sub-community of *Juncus-Racomitrium* rush-heath by the greater quantities of *Silene acaulis*, *Thymus polytrichus*, *Alchemilla alpina*, *Ranunculus acris*, *Persicaria vivipara*, *Plantago maritima* and *Polytrichum alpinum*. Stands with few calcicolous species and those with a very sparse sward have more *S. herbacea* than *Juncus-Racomitrium* rush-heath.

*Nardus-Carex* grass-heaths U7 can resemble *Juncus-Racomitrium* rush-heath but have much less *J. trifidus* and much more *Nardus stricta*.

#### ECOLOGY

*Juncus-Racomitrium* rush-heath is a montane community that occupies some of the most inhospitable and extreme environments in Britain. It occurs on barren wildernesses of stone on exposed plateaux and mountain summits at 1000 m or more above sea-level. The community represents the uppermost altitudinal zone of vegetation in Britain and Ireland - beyond this the climate is so severe that only scattered plants are able to grow amid a bare waste of stone. The substrate is usually unstable loose gravel, most commonly granite but in some places quartzite or Moine or Dalradian schist. The soils are mixtures of gravel and humus (McVean and Ratcliffe 1962) and are pervious and free-draining. *Juncus trifidus* can tolerate a moderate amount of snow-cover, and although many examples of *Juncus-Racomitrium* rush-heath are blown clear of snow by strong winds, some stands have an intermittent cover of up to 50 cm of snow throughout the winter and into early spring (McVean and Ratcliffe 1962).

#### DISTRIBUTION

The community is most common on the highest granite plateaux of the Cairngorm hills, but also occurs further west in the western Grampians, the Breadalbanes, the Torridon hills and on Arran.

Similar vegetation occurs in Norway, although these stands generally hold more snow during the winter, and occur at much higher altitudes.

### ***Carex bigelowii-Racomitrium lanuginosum* moss-heath (U10)**

#### DESCRIPTION

Silvery-grey-green, tightly-woven carpets of the woolly shoots of *Racomitrium lanuginosum* cover vast areas of the tops of high hills in the British uplands. These carpets are spiked through by slender grey-green shoots of the montane sedge *Carex bigelowii*, sprigs of *Vaccinium myrtillus*, fine leaves of *Deschampsia flexuosa* and *Festuca vivipara*, and scrambling stems of *Galium saxatile* and *Salix herbacea*.

There are three sub-communities. The grassy *Galium saxatile* sub-community U10a and the Typical sub-community U10b can look very similar. Both can have thick mats of *R. lanuginosum*, but there is more *Deschampsia flexuosa*, *Festuca ovina* and *Galium saxatile* in the *Galium* sub-community. In the south of Scotland, northern England and Wales there is usually very little *Racomitrium* in these heaths. The *Silene acaulis* sub-community U10c encompasses three quite different types of moss-heath. One type is species-rich; the sombre grey-green turf of *R. lanuginosum* and *C. bigelowii* is variegated by emerald-green, pink-flowered clumps of *Silene acaulis* and small trailing shoots of *Salix herbacea*, and there is a great array of herbs, such as *Alchemilla alpina*, *Persicaria vivipara*, *Minuartia sedoides*, *Armeria maritima*, *Sedum rosea*, *Luzula spicata*, *Saussurea alpina* and *Ranunculus acris*. The second type is species-poor, resembling the Typical sub-community but with a sprinkling of *Alchemilla alpina*, *Silene acaulis* and *Armeria maritima*, indicating a slightly more base-rich

substrate. The third type consists of a very open scatter of *Juncus trifidus*, *R. lanuginosum*, *Carex bigelowii*, *Festuca vivipara* and *Salix herbacea*, together with a few other species, including *A. maritima* and *Ochrolechia figida*.

On Aonach Mòr next to Ben Nevis there are moss-heaths of *Racomitrium ericoides* rather than *R. lanuginosum*, covering sandy soil at about 1220 m (McVean and Ratcliffe 1962). There are also *R. ericoides* heaths on gravel and rock debris on Stob Coire nan Lochan, one of the subsidiary peaks of Bidean nam Bian in Glen Coe.

#### DIFFERENTIATION FROM OTHER COMMUNITIES

*Carex-Racomitrium* moss-heath can be mistaken for other montane heaths containing *Racomitrium lanuginosum*. *Carex-Polytrichum* sedge-heath U8 has much less *R. lanuginosum*, fewer grasses, and more lichens, *Dicranum fuscescens* and *Polytrichum alpinum*. *Juncus-Racomitrium* rush-heath U9 has much more *Juncus trifidus* and lichens, although the flora of the *Salix* sub-community U9b is very similar to that of species-poor forms of the *Silene* sub-community of *Carex-Racomitrium* heath (see comments on p xxx). *Vaccinium-Racomitrium* heath H20 can resemble *Carex-Racomitrium* heath but has more dwarf shrubs and pleurocarpous mosses, and *Calluna-Racomitrium* heath H14 has more *Calluna vulgaris*.

Some forms of the *Racomitrium* sub-community of *Nardus-Galium* grassland U5e come close to *Carex-Racomitrium* moss-heath but they have more *Nardus stricta*, and can have *Calluna* too. Stands of the *Vaccinium-Deschampsia* sub-community of *Festuca-Agrostis-Galium* grassland U4e in exposed hilltop habitats can have a similar flora to the *Galium* sub-community of *Carex-Racomitrium* moss-heath, including montane plants, such as *Carex bigelowii*, *Diphysastrum alpinum* and *Salix herbacea*. Generally, the moss-heath community has more *R. lanuginosum* and less *Agrostis capillaris*, *Nardus*, *Anthoxanthum odoratum* and *Rhytidiadelphus squarrosus* than any forms of *Festuca-Agrostis-Galium* grassland.

*R. lanuginosum* can grow in thick pure mats on dry scree and even on walls in upland districts. In contrast to stands of *Carex-Racomitrium* heath, these moss mats are deep and not wind-pruned, and montane species, such as *Carex bigelowii*, are absent; this vegetation is not included within the NVC.

#### ECOLOGY

*Carex-Racomitrium* moss-heath clothes the barren inhospitable terrain of most of the higher summits and ridges in Britain and Ireland, extending from below 300 m in the far north-west to over 1000 m in the eastern Highlands. The community occupies ground that is blown free of snow by winter winds, leaving it exposed to freezing, desiccating winds. These heaths experience huge ranges of temperature over the year, from the bitterest winter winds to the most scorching summer sun. They endure weeks of blowing mist and rain, but can be dried out in clear, warm weather. In many places the ground is patterned by solifluction and frost-heave, so that plants have to contend with shifting unstable soils as well as a severe climate. Soils are generally shallow rankers or podsoles, and because of strong leaching are mostly acidic. In the south-west Highlands the *Silene* sub-community occurs primarily on hills with base-rich rocks, but further north it also occurs on more acid substrates where mineral availability is increased by frost-heaving. The species-poor form of the *Silene* sub-community containing *Juncus trifidus* and *Salix herbacea* occurs on rocky, soliflucted or wind-blasted ground with a firm surface of gravel and humus.

#### DISTRIBUTION

This summit heath is widespread throughout the uplands northwards from north Wales to Harris and north-west Sutherland. It is common on most of the higher upland massifs in the Scottish Highlands and it is here that the largest stands occur. The largest known single stand of *Carex-Racomitrium* moss-heath is on the summit of Ben Wyvis, where it stretches almost unbroken for more than 8 km (Ratcliffe 1977); there are also substantial tracts on the Drumochter hills, the Affric-Cannich hills and the Cairngorms. South of the Highlands, the community is almost entirely represented by the grassy *Galium* sub-community. The *Silene* sub-community is known only in Scotland.

*Racomitrium* heath is confined to arctic environments in some of the cooler oceanic parts of the world: Great Britain, Ireland, the Faroes, Norway, Iceland, Greenland and some of the sub-Antarctic islands (Ratcliffe and Thompson 1988). There is probably more of it in Britain than anywhere else in the world. The variant of *Carex-Racomitrium* heath dominated by *Racomitrium ericoides* instead of *R. lanuginosum* forms a floristic link with moss-heaths in Iceland and Jan Mayen (McVean and Ratcliffe 1962). *R. ericoides* is also locally dominant within stands of *R. lanuginosum* heath on the Faroes (Hobbs and Averis 1991a).

#### ***Polytrichum sexangulare-Kiaeria starkei* snow-bed (U11)**

## DESCRIPTION

In this snow-bed community the dense bright green shoots of the moss *Kiaeria starkei*, in many stands accompanied by *K. falcata* and *K. blyttii*, grow in carpets patterned with other montane bryophytes, such as the mosses *Polytrichum sexangulare*, *Andreaea alpina* and *Oligotrichum hercynicum*, and the liverworts *Lophozia opacifolia*, *Anthelia juratzkana* and *Pleurocladula albescens*. This low variegated velvety turf is studded with small montane vascular plants, including *Deschampsia cespitosa* ssp. *alpina*, *Saxifraga stellaris*, *Salix herbacea* and *Gnaphalium supinum*.

Two sub-communities are described in the NVC. The moss carpets of the Typical sub-community U11a are interspersed with *Carex bigelowii*, *Huperzia selago*, *Nardus stricta*, *Alchemilla alpina*, *Polytrichum alpinum* and *Racomitrium lanuginosum*, together with a few scarce montane bryophytes, such as *Conostomum tetragonum* and *Moerckia blyttii*. *Racomitrium fasciculare* and *R. ericoides* are common in some stands. The Species-poor sub-community U11b does not have this rich sward, but is described in the NVC as having more of the liverwort *Lophozia sudetica* than the Typical sub-community.

The NVC account of the community (Rodwell 1992) has been recognised to be inadequate because of the scarcity of samples (Rodwell *et al.* 1998). Many stands of *Polytrichum-Kiaeria* snow-bed outside the east-central Highlands do not fit well into either sub-community. Rothero (1991) has recorded many more samples and distinguished three main types: a Typical form; a hepatic-rich type with *Barbilophozia floerkei*, *Nardia scalaris*, *Cephalozia bicuspidata* and *Pleurocladula albescens*; and a *Racomitrium* type with *R. heterostichum*.

## DIFFERENTIATION FROM OTHER COMMUNITIES

*Polytrichum-Kiaeria* snow-bed has many species in common with *Salix-Racomitrium* snow-bed U12, but *Kiaeria* species and *Polytrichum sexangulare* are less common in the *Salix-Racomitrium* community, which is characterised by *Racomitrium heterostichum* and crusts of tiny, dark-coloured liverworts. The Typical sub-community can be confused with the *Alchemilla-Sibbaldia* community U14: *Alchemilla alpina*, *Sibbaldia procumbens*, *Silene acaulis*, *Juncus trifidus*, *Deschampsia cespitosa* and *Nardus stricta* occur in both vegetation types but are commoner in the *Alchemilla-Sibbaldia* community, where the place of the *Kiaeria* species is taken by *Racomitrium fasciculare* or other mosses.

## ECOLOGY

These ragged patches of mossy vegetation cling to the steep headwalls of shaded corries where snow lies late and deep far into spring. The vegetation may be uncovered for only a few weeks each year: for the rest of the time it is covered by snow in cold, dark and saturated conditions. The snow insulates the vegetation from really low temperatures, and the temperature experienced by the vegetation is rarely more than a few degrees below zero; as little as 5 cm of new snow is enough to provide effective insulation (Fryday 1997). The soils are moist but free-draining, leached and acid. Almost all stands are above 900 m and the community extends above 1200 m on the highest Scottish hills.

## DISTRIBUTION

The *Polytrichum-Kiaeria* snow-bed community is confined to the Scottish Highlands. There are some especially fine stands in the eastern and central Highlands, particularly on the Cairngorms, Ben Alder, Creag Meagaidh and the Affric-Cannich hills, and in the west on the Glen Coe hills and the Ben Nevis range. Elsewhere most stands are small.

Very similar snow-bed vegetation occurs in the mountains of mainland Europe, from Norway and Sweden to the Alps.

## ***Salix herbacea-Racomitrium heterostichum* snow-bed (U12)**

### DESCRIPTION

This is snow-bed vegetation in which the dark-green moss *Racomitrium heterostichum* and the diminutive willow *Salix herbacea* grow in mixed mats and crusts of bryophytes. The bryophyte mats are dotted with tiny vascular plants: silver-grey rosettes of *Gnaphalium supinum* and *Saxifraga stellaris*, yellow-green shoots of *Diphasiastrum alpinum*, and silvery-green leaves of *Alchemilla alpina*. The colourful lichen *Solorina crocea* occurs in some stands.

There are three sub-communities. The *Silene acaulis-Luzula spicata* sub-community U12a has a rather open sward of *Silene acaulis*, *Luzula spicata*, *Persicaria vivipara*, *Carex bigelowii* and *Saxifraga stellaris* speckling a discontinuous layer of either *Racomitrium lanuginosum*, *R. heterostichum* and *R. fasciculare* or tiny liverworts,

such as *Gymnomitrium concinatum*, *Nardia scalaris* and *Anthelia juratzkana*. The *Gymnomitrium concinatum* sub-community U12b consists of distinctive dark, grey-black patches of diminutive liverworts in intricately mixed mats. There may be as many as eight species of liverwort within a square centimetre (Rothero 1991); the most common species are *Gymnomitrium concinatum*, *Nardia scalaris*, *Anthelia juratzkana* and *Diplophyllum albicans*. The *Marsupella brevissima* sub-community U12c is characterised by the liverworts *Marsupella brevissima* and *Lophozia sudetica*.

Since the analysis undertaken for the NVC, further sampling has revealed that this type of vegetation is more variable than was originally realised (Rodwell *et al.* 1998). Rothero (1991) has suggested that the *Marsupella* sub-community, represented by only three quadrat samples in the NVC, should be recognised as a separate community comprising three sub-communities: a Typical sub-community with *Kiaeria falcata*; a *Salix herbacea* sub-community with much *Salix herbacea* and *Ditrichum zonatum*; and a *Cephalozia bicuspidata* ssp. *bicuspidata* sub-community with *Cephalozia bicuspidata*, *Nardia scalaris*, *Pleurocladula albescens* and *Kiaeria starkei*. Some Cairngorm snow-beds with much *Deschampsia flexuosa* in a mixed sward with *Juncus trifidus*, *Huperzia selago*, *Galium saxatile*, *Polytrichum alpinum*, *Dicranum fuscescens*, *Rhytidiadelphus loreus* and *Barbilophozia floerkei* are now considered to warrant a new sub-community of *Salix-Racomitrium* snow-bed (Rodwell *et al.* 1998). Snow-beds comprised of an almost pure sward of *Racomitrium heterostichum*, with a speckling of *Deschampsia cespitosa* ssp. *alpina* but little or no *Salix herbacea*, may also merit recognition. These correspond to the *Rhacomitreto-Dicranetum starkei* of McVean and Ratcliffe (1962), but their distinctiveness is not apparent in the NVC where they have been subsumed within the broader *Silene-Luzula* sub-community.

Rothero (1991) has sampled a *Pohlia ludwigii* snow-bed that is related to the *Salix-Racomitrium* community but which is not included in the NVC. This vegetation is dominated by *P. ludwigii*, and contains other species, such as *Polytrichum sexangulare*, *Nardia scalaris*, *Deschampsia cespitosa* and *Marsupella sphacelata*, and less commonly *Andreaea nivalis*, *Racomitrium heterostichum*, *Lophozia sudetica*, *Marsupella brevissima*, *Saxifraga rivularis* and *Salix herbacea*.

#### DIFFERENTIATION FROM OTHER COMMUNITIES

The *Salix-Racomitrium* community can be confused with other snow-beds and moss-heaths. The *Gymnomitrium* sub-community, with its dark crusts of liverworts dotted with *Salix herbacea*, is unlike any other type of British vegetation. Stands with a continuous layer of *Anthelia juratzkana* may superficially resemble *Anthelia-Sphagnum* springs M31, but this community is characterised by *A. julacea* rather than *A. juratzkana*, has much *Sphagnum denticulatum*, *Scapania undulata* and *Marsupella emarginata*, and lacks *Salix herbacea* and *Gymnomitrium concinatum*.

The herb-rich *Silene-Luzula* sub-community might be confused with the *Silene* sub-community of *Carex-Racomitrium* moss-heath U10c, with the *Salix* sub-community of *Juncus-Racomitrium* rush-heath U9b, or with *Alchemilla-Sibbaldia* dwarf-herb vegetation U14. *Carex bigelowii*, *Salix herbacea*, *Juncus trifidus*, *Luzula spicata* and *Silene acaulis* can grow in all of these vegetation types. The two montane heath types can usually be distinguished by having more *Racomitrium lanuginosum* and *Vaccinium myrtillus* than the snow-bed vegetation, little *R. heterostichum*, and none of the characteristic crust-forming liverworts. *R. heterostichum* can be common in *Alchemilla-Sibbaldia* vegetation, and *R. fasciculare* usually grows here too, but *Alchemilla alpina* and *Sibbaldia procumbens* are far more common than they are in *Salix-Racomitrium* snow-bed.

Species-poor examples of the *Salix-Racomitrium* community dominated by *R. heterostichum* are distinctive, but they can be small and hard to pick out where they occur within larger stands of *Carex-Racomitrium* heath. Compared to the surrounding heath vegetation, *Salix-Racomitrium* snow-beds have more *R. heterostichum* and less *R. lanuginosum* and *Vaccinium* species. *Carex-Racomitrium* heath occurs in exposed places that are blown clear of snow, whereas the *Salix-Racomitrium* community occupies hollows or slopes where snow accumulates.

#### ECOLOGY

Like *Polytrichum-Kiaeria* snow-beds, the *Salix-Racomitrium* community occurs in places where growing conditions are inimical to most plants. These places are cold and wet, have a short growing-season, and the vegetation is often disturbed by solifluction, flooded with icy water and buried beneath snow and wind-blown soil and debris. The community is recorded only above 600 m and extends to over 1200 m. Both types of snow-bed occur on the coldest, highest parts of the hills where snow persists into the summer, but the *Salix-Racomitrium* community occupies wetter, less stable ground than the *Polytrichum-Kiaeria* community. It is most common on the steep upper slopes of corries where the ground is disturbed by amorphous solifluction

as well as by the tearing effects of the snow-field itself moving down the slope as its weight increases. The thin skin of vegetation is also often disrupted by water running from the melting snow. It is quite common for the liverwort crust to roll over on itself, burying some of the plants but exposing new soil for recolonisation (McVean and Ratcliffe 1962). The community can occur on slopes of any aspect, but is restricted to sheltered places where snow can accumulate.

#### DISTRIBUTION

This community is the more widespread of the two moss-dominated snow-beds. It is distributed from Ben More Assynt in the north-west Highlands to the Breadalbanes in the southern Highlands, with outliers on Ben More in Mull and in the Southern Uplands. It is particularly common in the Cairngorms and there are also good stands on other hills with high plateaux, such as Ben Alder and Beinn Dearg at the head of Loch Broom.

There is similar vegetation in Scandinavia, where it is much more extensive because snow lies for longer over larger areas of ground.

### ***Deschampsia cespitosa*-*Galium saxatile* grassland (U13)**

#### DESCRIPTION

This NVC community brings together an upland grassland and a snow-bed: two types of vegetation that differ ecologically but which share the species *Deschampsia cespitosa*, *Galium saxatile* and *Agrostis capillaris*, and the mosses *Rhytidiadelphus loreus*, *Hylocomium splendens* and *Polytrichum alpinum*.

The two sub-communities of *Deschampsia*-*Galium* grassland look very different even though their flora has so much in common. The *Anthoxanthum odoratum*-*Alchemilla alpina* sub-community U13a clothes steep, irrigated, shaded slopes. It is a short, dense, tufted, dark-green grassland composed of the tough, sharp-ridged leaves of *D. cespitosa*. *Agrostis canina*, *Anthoxanthum odoratum* and *Festuca vivipara* grow with *D. cespitosa*, and the turf is flecked with a few small species, such as *Viola palustris*, *Potentilla erecta*, *Alchemilla alpina*, *Galium saxatile* and *Blechnum spicant*. At the foot of the vascular plants there is a thin layer of bryophytes, of which the most common are *Hylocomium splendens*, *Thuidium tamariscinum*, *Rhytidiadelphus loreus*, *R. squarrosus*, *Diplophyllum albicans* and *Marsipella emarginata*. In contrast, the *Rhytidiadelphus loreus* sub-community U13b is a golden-yellow, mossy snow-bed that occupies steep shaded slopes at high altitudes, where it commonly forms crescent-shaped patches. The deep, lustrous blanket of *R. loreus* is variegated with a little *Hylocomium splendens*, *Pleurozium schreberi* and *Polytrichum alpinum*, and is dotted with small tufts of *D. cespitosa* (many plants belonging to ssp. *alpina*), *Carex bigelowii*, *Saxifraga stellaris*, *Nardus stricta*, *Galium saxatile* and *Potentilla erecta*.

There is also a herb-rich form of the *Anthoxanthum*-*Alchemilla* sub-community in which the sward is enriched with small base-tolerant species, such as *Thalictrum alpinum*, *Persicaria vivipara*, *Carex pulicaris*, *C. viridula* ssp. *oedocarpa* and even *Thymus polytrichus*. This is not described in the NVC.

#### DIFFERENTIATION FROM OTHER COMMUNITIES

The *Anthoxanthum*-*Alchemilla* sub-community is distinct from other upland acid grasslands in being dominated by *Deschampsia cespitosa*. Additionally, *Festuca ovina*, *Nardus stricta* and *Juncus squarrosus*, which play such an important part in most sub-montane acid grasslands, are scarce in this vegetation type. It is possible to confuse the herb-rich form of the *Anthoxanthum*-*Alchemilla* sub-community with stands of the *Agrostis*-*Rhytidiadelphus* sub-community of *Luzula*-*Geum* tall-herb vegetation U17c, but this occurs on more calcareous soils and includes tall mesotrophic forbs, such as *Alchemilla glabra*, *Angelica sylvestris*, *Trollius europaeus*, *Crepis paludosa*, *Filipendula ulmaria*, *Geranium sylvaticum* and *Cirsium heterophyllum*. These tall forbs do not usually grow in *Deschampsia*-*Galium* grassland, and if they do occur it is as a few small individuals that do not make a great contribution to the sward.

The *Rhytidiadelphus* sub-community is usually distinctive in having so much *Rhytidiadelphus loreus*; this species is more common here than in any other recognised British vegetation type. Some stands of the sub-community can look rather like *Carex*-*Racomitrium* moss-heath U10, but contain more *R. loreus* and *Hylocomium splendens*, and less *Racomitrium lanuginosum*.

#### ECOLOGY

The *Anthoxanthum*-*Alchemilla* sub-community is a montane grassland of high, shaded slopes, mostly above 500 m. It typically occurs on the steep headwalls of corries or under cliffs, where acid soils are constantly flushed with cold water, often running from melting snow. *Deschampsia cespitosa* can out-compete other grasses on these

saturated soils in a climate where the summers are short and cool and much of the winter precipitation falls as snow. The herb-rich form occurs where there is irrigation by base-rich water.

The *Rhytidiadelphus* sub-community generally occurs at altitudes over 600 m, on shaded slopes around the upper rims of slopes and corries where snow lies deep far into the spring. It can also form fine-scale mosaics with *Carex-Racomitrium* heath; in such situations, *Deschampsia-Galium* grassland occupies shallow sheltered hollows, with *Carex-Racomitrium* heath on the surrounding ground where conditions are more exposed. This sub-community seems to need a cool oceanic climate with a high precipitation; many of its sites receive over 220 wet days a year, and in winter much of the precipitation falls as snow.

#### DISTRIBUTION

The *Anthoxanthum-Alchemilla* sub-community is fairly common throughout the Scottish Highlands, and there are outliers in the Southern Uplands, the Lake District and north Wales. It is most extensive in the western and central Highlands, on high hills such as Ben Nevis, the Affric-Cannich hills, Foinaven and Ben Alder. The herb-rich form is rare in the west Highlands. The *Rhytidiadelphus* sub-community is restricted to the Highlands, extending south to Ben Lomond. It is most common in the north-west Highlands, especially in the high north-facing corries of the Fannich Hills, the Monar Forest hills and on Beinn Dearg at the head of Loch Broom; there are also large expanses on Ben Wyvis.

*Deschampsia cespitosa* grasslands similar to the *Anthoxanthum-Alchemilla* sub-community occur in Scandinavia, but the *Rhytidiadelphus* sub-community is apparently confined to Great Britain and Ireland

### ***Alchemilla alpina-Sibbaldia procumbens* dwarf-herb community (U14)**

#### DESCRIPTION

This community consists of a loosely-woven turf of *Sibbaldia procumbens* and *Alchemilla alpina*, both of which have delicate, silvery-green leaves and drifts of yellow-green flowers in summer. Other characteristic vascular plants include *Carex bigelowii*, *C. pilulifera*, *Galium saxatile*, *Deschampsia cespitosa*, *D. flexuosa*, *Gnaphalium supinum* and *Thymus polytrichus*. These plants are commonly set in a matrix of golden-brown *Racomitrium fasciculare* or greyish *R. ericoides*, which is tufted with small shoots of a few other snow-tolerant bryophytes, such as *Conostomum tetragonum* and *Oligotrichum hercynicum*.

#### DIFFERENTIATION FROM OTHER COMMUNITIES

The *Alchemilla-Sibbaldia* dwarf-herb community may be confused with the similar *Festuca-Alchemilla-Silene* dwarf-herb community CG12, but it has fewer grasses, fewer calcicoles, such as *Silene acaulis*, *Saxifraga hypnoides* and *S. oppositifolia*, and more *Galium saxatile*. Some stands resemble forms of the *Silene* sub-community of *Carex-Racomitrium* moss-heath U10c, but the stricter calcicoles and *Racomitrium lanuginosum* that usually characterise the heath vegetation are scarcer in the *Alchemilla-Sibbaldia* community. The habitats of these two vegetation types also differ: *Carex-Racomitrium* heath occurs on very exposed ground, whereas the *Alchemilla-Sibbaldia* community is a snow-bed and occupies more sheltered slopes and hollows. *Sibbaldia* and *Alchemilla alpina* can grow in the Typical sub-community of *Polytrichum-Kiaeria* snow-bed U11a, but this has a thicker and more variegated carpet of mosses, including *Kiaeria* species as well as many other snow-tolerant species.

#### ECOLOGY

This snow-bed community occurs at high altitudes (generally over 600 m) where snow accumulates in gullies or hollows on high ridges and plateaux, in corries, and on sheltered slopes that face north or east. It is most common on base-rich rocks, such as the Dalradian schist of the Breadalbanes, but also occurs over acid rocks, such as the Cairngorm granite, where the vegetation is irrigated by water running from melting snow. Although the community is herb-rich and can contain calcicoles, such as *Thalictrum alpinum* and *Persicaria vivipara*, the soils are usually incipient podsoles with a pH between 4.8 and 5.4 (McVean and Ratcliffe 1962). A common habitat is the unstable upper rim of high corries where the soil is disturbed by solifluction during the winter. This disturbance redistributes nutrients in the soil and may enable calcicoles to grow on substrates that would otherwise be too acid.

#### DISTRIBUTION

The *Alchemilla-Sibbaldia* dwarf-herb community is widespread but rather scarce in the Scottish Highlands. Most individual stands are small. Similar vegetation lacking *Sibbaldia* but with *Alchemilla alpina* and *Potentilla erecta* occurs at high altitude in the Lake District and in the western Highlands (McVean and Ratcliffe 1962), where it may be as dependent on intermittent irrigation as it is on late-lying snow.

There is similar vegetation in Norway and Sweden.

### ***Saxifraga aizoides*-*Alchemilla glabra* banks (U15)**

#### DESCRIPTION

This community consists of dripping mats of diverse, species-rich vegetation sprawling over wet rocks and shelving ledges. The most common species is *Saxifraga aizoides* with its grey-green leaves and the dazzling spectacle of its cascading yellow flowers in summer. The stands are tangled with trailing stems of *S. oppositifolia*, lush green leaves of *Alchemilla glabra*, small plants of *Persicaria vivipara* and *Thalictrum alpinum*, yellow-green spikes of *Selaginella selaginoides*, and the sedges *Carex viridula* ssp. *oedocarpa*, *C. dioica* and *C. pulicaris*. Forming layers on the rock surfaces is a rich array of bryophytes including *Ctenidium molluscum*, *Orthothecium rufescens*, *Palustriella commutata* and *Molendoa warburgii*.

#### DIFFERENTIATION FROM OTHER COMMUNITIES

This vegetation type is distinctive but could be confused with *Luzula-Geum* tall-herb vegetation U17. *Saxifraga-Alchemilla* banks contain more *Saxifraga aizoides*, *S. oppositifolia*, *Pinguicula vulgaris*, *Alchemilla alpina*, *Selaginella selaginoides*, *Thalictrum alpinum* and *Carex pulicaris* than the *Luzula-Geum* community, and less *Luzula sylvatica*, *Geum rivale* and *Angelica sylvestris*. *Saxifraga-Alchemilla* banks may also resemble densely-vegetated examples of *Carex-Saxifraga* mire M11 but have more forbs, such as *Thalictrum alpinum*, *Alchemilla glabra*, *A. alpina*, *Persicaria vivipara* and *Saxifraga oppositifolia*, and less *Carex viridula* ssp. *oedocarpa*, *C. panicea*, *Blindia acuta*, *Drepanocladus revolvens*, *Campylium stellatum* and *Aneura pinguis*.

#### ECOLOGY

The *Saxifraga-Alchemilla* community is almost confined to steep faces of basic rock with a copious supply of base-rich water dripping through the foliage. Stands can also occur on steep, flushed gravelly ground below cliffs and on wet grassy banks. The essential condition is constant irrigation by base-rich water. The community occurs on slopes of all aspects, but most sites face north or east (since these tend to be the wettest slopes). Many of the constituent species are montane plants, and this is generally a high-level community growing at altitudes between 200 m and almost 900 m, although it does occur locally near sea-level on the Isle of Skye. The soil is usually a wet, silty humus that can accumulate to a depth of 30 cm (McVean and Ratcliffe 1962), but some stands form hanging curtains over steep, wet rocks with almost no soil at all.

#### DISTRIBUTION

This is a community of the Scottish Highlands, with a few outlying stands in the Lake District. Similar vegetation but without *Saxifraga aizoides* occurs in Snowdonia. Some of the best and most extensive stands of *Saxifraga-Alchemilla* vegetation are in the Breadalbanes, on the calcareous Dalradian schist that extends from the Cowal peninsula to Caenlochan. There are also some fine examples on base-rich exposures of the Moine schist, such as in the Monar Forest and on Beinn Dearg at the head of Loch Broom in Ross, and on the base-rich Furoid beds and Serpulite grits that outcrop in north-west Ross and Sutherland, notably on Meall Horn in the Reay Forest. The stands in the Lake District are on the base-rich Borrowdale Volcanic rocks, and illustrate the importance of the Lake District hills as a refugium for arctic-alpine plants.

There is vegetation resembling the *Saxifraga-Alchemilla* community in Norway and Sweden, although it is ecologically rather different, most examples being associated with deep snow rather than with steep, irrigated slopes. A community more like the British vegetation occurs on flushed basalt cliffs and slopes in the Faroes (Hobbs and Averis 1991b).

### ***Luzula sylvatica*-*Vaccinium myrtillus* tall-herb community (U16)**

#### DESCRIPTION

This community consists of swards of tall herbs and ferns with much *Luzula sylvatica* and usually *Vaccinium myrtillus*. Beneath the vascular plants there are big sprawling wefts of mosses, such as *Rhytidiadelphus loreus*, *R. squarrosus*, *Hypnum jutlandicum*, *Hylocomium splendens*, *Pleurozium schreberi* and *Scleropodium purum*.

There are three sub-communities. The *Dryopteris dilatata*-*Dicranum majus* sub-community U16a is the most lush and diverse, and is largely confined to inaccessible ledges. Here the luxuriant rich green herbage of *L. sylvatica* and *V. myrtillus* is enriched with large ferns; *Dryopteris dilatata*, *D. borrieri*, *Athyrium filix-femina* and *Oreopteris*

*limbosperma* are among the most common species. At a lower level in the sward there is layer of smaller plants, including *Oxalis acetosella* with its delicate folded leaves, tough clumps of *Blechnum spicant*, and delicate soft-green fronds of *Phegopteris connectilis* and *Gymnocarpium dryopteris*; there can also be a little *Alchemilla alpina*. The *Anthoxanthum odoratum-Festuca ovina* sub-community U16b is a more grassy assemblage of lightly grazed or ungrazed hillsides, where it occurs in mosaics with heaths and grasslands. In these stands there are fewer ferns, and the clumps of *L. sylvatica* and *V. myrtillus* are entwined with grasses, such as *Festuca ovina*, *Anthoxanthum odoratum* and *Agrostis canina*, as well as the common grassland forbs *Potentilla erecta* and *Galium saxatile*. The Species-poor sub-community U16c, as its name implies, takes in the impoverished, almost pure swards of *L. sylvatica* that grow on cliffs, scree and open hillsides.

#### DIFFERENTIATION FROM OTHER COMMUNITIES

The *Luzula-Vaccinium* tall-herb community can be quite similar to the *Luzula-Geum* tall-herb community U17, but it is less species-rich and generally lacks *Geum rivale*, *Angelica sylvestris*, *Sedum rosea*, *Filipendula ulmaria* and calcicole species. Although *Vaccinium myrtillus* can be common in *Luzula-Vaccinium* vegetation, there should not be any confusion with the various forms of sub-montane and montane *Vaccinium* heath, which have much less *Luzula sylvatica* and fewer ferns. The *Oreopteris-Blechnum* community U19 can look rather like the more fern-rich stands of the Species-poor sub-community of *Luzula-Vaccinium* vegetation, but is dominated by *Oreopteris limbosperma*. *Dryopteris affinis* vegetation (Rodwell *et al.* 1998) can also resemble the Species-poor sub-community, but is distinguished by the distinctive golden-green tussocks of *D. affinis* that are prominent among mixtures of grasses, forbs and bryophytes. *L. sylvatica* can form pure swards in lightly grazed or ungrazed birch and oak woodlands on acid ground, but such vegetation is immediately distinguished from the *Luzula-Vaccinium* community by the presence of a tree canopy.

#### ECOLOGY

The succulent shoots of *Luzula sylvatica* are relished by grazing animals and *Luzula-Vaccinium* vegetation is rare except in places where grazing is light or absent. The community is the classic tall-herb vegetation of acid rock ledges that are inaccessible to grazing animals. More impoverished stands occur on accessible ground, and even on heavily-grazed hills the community can persist on very steep, rocky slopes, on the tops of large boulders, or on islands in lochs. On Orkney, *Luzula-Vaccinium* vegetation occurs in the unusual habitat of open moorland as long as the intensity of grazing is low, but rising numbers of sheep soon eliminate it.

The community is most common around or above the altitude of the former tree-line between 400 m and 600 m, where it probably represents a near-natural form of vegetation, but it descends almost to sea-level in the cool oceanic climate of north-west Scotland. Stands at higher altitudes can be covered by snow for part of the winter. Soils are usually base-poor raw humus and can be up to 60 cm deep (McVean and Ratcliffe 1962). *Luzula-Vaccinium* vegetation usually occurs on shaded slopes facing between north and east and can be mildly flushed. Gradations into the richer *Luzula-Geum* community are quite common, reflecting changes in the underlying rock or flushing with base-rich water.

#### DISTRIBUTION

The *Luzula-Vaccinium* community occurs on acid cliff ledges and open slopes throughout the Highlands, Orkney, Shetland, the Inner and Outer Hebrides, the Southern Uplands, the Lake District and north Wales. It is uncommon in the Pennines and south Wales, and is rare in south-west England. Some of the largest stands are in the far north and west, for example on the Cowal Hills in Argyll, Ben Hope and Ben Loyal in Sutherland, and St Kilda.

There is similar vegetation on cliffs in Ireland, for example on the Mourne Mountains (Hobbs and Averis 1991b) and in parts of Kerry and Cork. Related vegetation also occurs in ungrazed sub-alpine birch woodlands and on steep treeless slopes in western Norway and on the Faroes.

### ***Luzula sylvatica-Geum rivale* tall-herb community (U17)**

#### DESCRIPTION

The *Luzula-Geum* tall-herb community comprises luxuriant herb-rich vegetation on ungrazed or lightly-grazed basic cliffs and hillsides. As with the *Luzula-Vaccinium* community U16, the most species-rich and lush stands are on inaccessible ledges where the plants are safe from the predations of sheep and deer. In such situations there can be stunningly rich mixtures of tall herbs and ferns, growing in deep meadows on larger ledges and hanging over sheer rock faces in shaggy mats and curtains dripping with water. The most common species in the community are *Luzula sylvatica*, *Geum rivale*, *Deschampsia cespitosa*, *Alchemilla glabra*, *A. alpina*, *Trollius europaeus*, *Oxyria digyna*, *Crepis paludosa*, *Filipendula ulmaria*, *Sedum rosea*, *Angelica sylvestris*, *Ranunculus acris* and *Thymus polytrichus*, all with a glowing profusion of bright flowers in summer. They are accompanied by

a great array of smaller plants, including *Selaginella selaginoides*, *Saxifraga oppositifolia*, *S. aizoides*, *Carex pulicaris* and *Thalictrum alpinum*. There are also mats and cushions of bryophytes among the larger plants and hanging over the ledges, with *Tortella tortuosa*, *Ctenidium molluscum*, *Neckera crispa*, *Anoetangium aestivum* and other calcicoles.

The community varies in floristic composition over its geographical range and the four sub-communities reflect this. The *Alchemilla glabra-Bryum pseudotriquetrum* sub-community U17a clothes ledges where the seepage of water is more or less continuous, and includes plants of wet ground, such as *Chrysosplenium oppositifolium*, *Saxifraga aizoides* and the moss *Philonotis fontana*. The richest swards belong to the *Geranium sylvaticum* sub-community U17b; most of the magnificent tall-herb swards of the mica-schist ledges of the Breadalbane hills are of this type. *Rubus saxatilis*, *Geranium sylvaticum*, *Trollius europaeus*, *Thalictrum alpinum*, *Heracleum sphondylium*, *Polystichum lonchitis*, *Carex pulicaris*, *Ctenidium molluscum*, *Dicranum scoparium* and *Plagiochila asplenioides* are all more common here than in the other forms of the community. The *Agrostis capillaris-Rhytidiadelphus loreus* sub-community U17c is grassier. The tall herbs are not so tightly packed, and the vegetation includes some typical grassland species, such as *Rumex acetosa*, *Ranunculus acris* and *Plantago lanceolata*. This sub-community can occur on open slopes where grazing is not heavy, and is the herb-rich counterpart of *Deschampsia-Galium* grassland U13. The *Primula vulgaris-Hypericum pulchrum* sub-community U17d has a lowland and woodland element in the flora, including *Calluna vulgaris*, *Primula vulgaris*, *Teucrium scorodonia*, *Hyacinthoides non-scripta* and *Allium ursinum*.

#### DIFFERENTIATION FROM OTHER COMMUNITIES

The most rich and luxuriant stands of the *Geranium* sub-community are quite unmistakable: no other type of vegetation in the British uplands has so great a profusion of tall flowering herbs. Some examples of *Luzula-Geum* vegetation resemble the *Luzula-Vaccinium* tall-herb community (its counterpart on acid soils), but have more *Geum rivale*, *Sedum rosea*, *Angelica sylvestris*, *Alchemilla glabra*, *Filipendula ulmaria* and other mesotrophic forbs. The *Saxifraga-Alchemilla* community U15 shares many species with the *Alchemilla-Bryum* sub-community of *Luzula-Geum* vegetation, but is usually distinct in having more *Saxifraga aizoides*, *S. oppositifolia*, *Pinguicula vulgaris*, *Alchemilla alpina*, *Selaginella selaginoides*, *Thalictrum alpinum* and *Carex pulicaris*, and less *Luzula sylvatica*, *Angelica sylvestris* and *Geum rivale*. Lightly-grazed stands of the *Agrostis-Rhytidiadelphus* sub-community can resemble the *Anthoxanthum-Alchemilla* sub-community of *Deschampsia-Galium* grassland U13a, but *Deschampsia* grassland is less species-rich and has a sparser scatter of tall herbs. Heathy stands of the *Primula-Hypericum* sub-community have some similarities to the *Thymus-Carex* sub-community of *Calluna-Erica* heath H10d, but tall forbs, such as *Angelica sylvestris*, *Geum rivale*, *Sedum rosea* and *Filipendula ulmaria*, are more common. *Fraxinus-Sorbus-Mercurialis* woodland W9 and *Salix-Luzula* scrub W20 can have a similar flora to the *Luzula-Geum* community but with the addition of a canopy of trees or shrubs.

#### ECOLOGY

The *Luzula-Geum* community is the mesotrophic equivalent of *Luzula-Vaccinium* tall-herb vegetation and is likewise confined to places where grazing is light or absent. It is most widespread on cliff ledges and in ravines, and is only locally extensive on open slopes. Most stands are at altitudes above 300 m, but the *Primula-Hypericum* sub-community can occur at lower altitudes in the Hebrides. The soils are fertile brown loams with a pH between 4.8 and 5.4 (McVean and Ratcliffe 1962) and are usually flushed and moist. The community can occur on slopes of any aspect but most examples are on north-facing or east-facing cliff ledges and steep hillsides that are shaded and often dripping with water. There is always some base-enrichment, either directly from the rock or from irrigating water. Some stands have a considerable cover of snow in winter, although this does not usually lie very late in the spring (McVean and Ratcliffe 1962).

#### DISTRIBUTION

*Luzula-Geum* vegetation is widely distributed in upland areas from south Wales to Shetland. Some of the sub-communities have distinctive distributions. For example, the *Alchemilla-Bryum* sub-community is the most common form south of the Highlands, and the *Primula-Hypericum* sub-community is the most common type in the far west Highlands and the Hebrides. Stands are rarely large, but they can form a high proportion of the total cliff vegetation on the Dalradian schist and limestone in the Breadalbanes, as seen on Ben Lui, Beinn Heagsarnich and Ben Lawers.

Similar forms of tall-herb vegetation occur in Norway, Sweden, Ireland, the Faroe Islands, Greenland and Iceland.

### ***Cryptogramma crispa-Athyrium distentifolium* snow-bed (U18)**

#### DESCRIPTION

This vegetation type comprises dense, lush patches of ferns tucked between boulders and stones; the vivid green fronds of summer and the dead rusty-red collapsed remains in winter stand out equally strongly against the stony habitat. The two most common ferns are *Athyrium distentifolium* and *Cryptogramma crispa*, and there can also be a few plants of *Oreopteris limbosperma*, *Dryopteris dilatata* or the rare *D. oreades*. Bryophytes are very common, with species such as *Rhytidiadelphus loreus*, *Hylocomium splendens* and *Barbilophozia floerkei* growing in mixed mats. There are usually tufts of *Deschampsia cespitosa*, together with other plants that can tolerate late-lying snow, including *Gnaphalium supinum*, *Sibbaldia procumbens*, *Kiaeria starkei*, *Polytrichum sexangulare*, *Oligotrichum hercynicum* and *Lophozia sudetica*.

#### DIFFERENTIATION FROM OTHER COMMUNITIES

This form of snow-bed vegetation is likely to be confused only with the less montane *Cryptogramma-Deschampsia* community U21. *Cryptogramma-Athyrium* snow-bed has montane species, such as *Athyrium distentifolium*, *Dryopteris oreades*, *Alchemilla alpina* and *Carex bigelowii* (although *A. alpina* also grows in *Cryptogramma-Deschampsia* vegetation in the Lake District and on Skye), and more extensive and diverse bryophyte mats.

#### ECOLOGY

The *Cryptogramma-Athyrium* community occurs on stable scree, among boulders, on ledges and on steep rocky ground (McVean and Ratcliffe 1962). It is restricted to high altitudes, generally above 800 m, in places where snow lies moderately late and protects the frost-sensitive ferns from freezing. Most stands are on cold sheltered slopes facing between north and east. The community usually occurs over acid rocks, but there are many stands on moderately basic outcrops of Moine Schist. The soils are free-draining acid mixtures of humus, sand and silt with a pH around 4.1 (McVean and Ratcliffe 1962). Melting snow helps to keep the soils moist throughout the growing season.

#### DISTRIBUTION

This community is widespread but scarce in the Scottish Highlands, occurring from Ben More Assynt in the north to Ben Lui in the south. It is most common on the high Moine and Dalradian schist hills, notably Ben Nevis, Bidean nam Bian, Creag Meagaidh and Ben Alder, and on the hills that lie along the main watershed of western Scotland: the Fannich Hills, the Monar Forest and the Affric-Cannich hills. There are outliers in the Cairngorms and on Lochnagar.

There is similar vegetation in Scandinavia, although *Cryptogramma crispa* is largely confined there to the west of Norway (McVean and Ratcliffe 1962).

### ***Oreopteris limbosperma-Blechnum spicant* community (U19)**

#### DESCRIPTION

This vegetation type comprises dense, lush, yellow-green stands of the tufted fern *Oreopteris limbosperma*, growing in patches on steep sub-montane slopes or running in linear stands up shallow grassy gullies. The lemon scent of the *Oreopteris* is most noticeable when the fronds are brushed in passing, but it can be detected from a distance on still warm days. Under the fragrant canopy of fern fronds there is a sprinkling of *Blechnum spicant*, and in some places *Oreopteris* is accompanied by some *Dryopteris dilatata* or *D. filix-mas*. On the ground, a thick golden-green carpet of the pleurocarpous mosses *Hylocomium splendens*, *Pleurozium schreberi* and *Rhytidiadelphus loreus* is pricked through by small vascular plants, such as *Oxalis acetosella*, *Galium saxatile*, *Festuca ovina*, *Agrostis capillaris* and *Anthoxanthum odoratum*.

#### DIFFERENTIATION FROM OTHER COMMUNITIES

This community is very distinctive as it is the only type of British non-woodland vegetation that is dominated by *O. limbosperma*.

#### ECOLOGY

The *Oreopteris-Blechnum* community occurs on steep slopes with shallow, acid, well-drained peaty soil. It commonly forms dense stands in sheltered gullies and ravines but can also cover large areas on open slopes, especially those facing north or east. Steep stream banks are another favoured habitat. The ferns are sensitive to frost and desiccation, so the community is most common in sheltered situations, and rarely extends above 600 m or the altitudinal limit of woodland. *Oreopteris-Blechnum* vegetation usually occurs in a matrix of sub-montane heaths and grasslands.

Similar vegetation can make up the ground-layer of birch, oak, Scots pine and juniper woodlands, and can form pure stands around their upper margins and in clearings, for example on Creag Fhiaclach in the Cairngorms and in the Morrone Birkwood near Braemar.

#### DISTRIBUTION

The community is widespread throughout the British uplands from north-west Sutherland to Wales and south-west England. It is very common in the Breadalbane region and in Argyll.

There is similar vegetation in western Norway, where it may form a fringe at the upper edges of birch woodland under an open canopy of *Juniperus communis* and *Salix lapponum*. It also occurs as dense stands on open north-facing slopes in the extreme west of Norway.

### ***Pteridium aquilinum-Galium saxatile* community (U20)**

#### DESCRIPTION

The *Pteridium-Galium* community includes vegetation dominated by *Pteridium aquilinum*, and is one of the easiest upland plant communities to recognise. The patches of bracken, which may be very extensive, are a rich dark green in summer, adding texture rather than colour to the landscape. They turn bright red-gold in winter, when they stand out against the sombre bleached grasses and dark heather on lower hill slopes.

There are three sub-communities. In the *Anthoxanthum odoratum* sub-community U20a there is a short grassy sward beneath the bracken fronds consisting of *Agrostis capillaris*, *Festuca ovina*, *Anthoxanthum odoratum*, *Holcus lanatus*, *Galium saxatile*, *Potentilla erecta*, *Rumex acetosa* and *Viola riviniana*, and the mosses *Rhytidiadelphus squarrosus*, *Hypnum jutlandicum* and *Scleropodium purum*. There can be a few woodland herbs, such as *Hyacinthoides non-scripta* and *Oxalis acetosella*. The heathy *Vaccinium myrtillus-Dicranum scoparium* sub-community U20b includes stands in which an uneven layer of *Vaccinium myrtillus* and, in some places, *Calluna vulgaris* grows beneath the bracken in a short mossy turf with much *Dicranum scoparium*, *Rhytidiadelphus loreus* and *Pleurozium schreberi*. In the Species-poor sub-community U20c the tall, dense fronds of bracken rise from a thick carpet of their own leaf litter, and there is little room for anything else to grow.

In some places in the Highlands there are patches of bracken-dominated vegetation related to the *Pteridium-Galium* community but with much *Molinia caerulea*. This vegetation is usually closely associated with *Molinia-Potentilla* grassland M25 and *Trichophorum-Erica* wet heath M15.

#### DIFFERENTIATION FROM OTHER COMMUNITIES

This community can be confused with *Pteridium-Rubus* scrub W25, in which bracken is also dominant. Compared with the *Pteridium-Galium* community, *Pteridium-Rubus* scrub usually has more *Rubus fruticosus* and *R. idaeus*, and a more herb-rich flora, including woodland plants, such as *Hyacinthoides non-scripta*, *Teucrium scorodonia*, *Urtica dioica*, and *Stachys sylvatica*. Conversely, *Galium saxatile* and *Potentilla erecta* are very common in *Pteridium-Galium* vegetation, especially in the *Anthoxanthum* sub-community, but are scarce in *Pteridium-Rubus* scrub.

#### ECOLOGY

The *Pteridium-Galium* community is typical of the zone where the farmed lowlands adjoin the unenclosed uplands. It is most common on lower hill slopes and on marginal ground, including abandoned fields, where it forms mosaics with heaths, grasslands and woodlands. The community covers fairly deep, well-drained but moist, base-poor and infertile soils. It is absent from wet ground and strongly flushed slopes. Bracken is intolerant of frost and its altitudinal range is therefore limited by exposure. Soils at higher altitudes also tend to be too shallow, rocky or peaty, although the community can develop on dry peat where bogs have been cut-over or drained. The upper altitudinal limit of the *Pteridium-Galium* community appears broadly to correspond with that of native woodland at around 600 m; it is most extensive below 450 m. Stands of *Pteridium-Galium* vegetation can cover huge areas of hillside, but it is also common to see small, discrete patches that are perhaps the beginning of new colonies.

#### DISTRIBUTION

This community is common throughout the British uplands, and is thinly scattered in the lowlands. It is one of the more extensive types of vegetation in many parts of England, Wales and the south and west of Scotland, including the Inner Hebrides. It thins out somewhat in the north, possibly because the climate is too harsh, and is rare on the very acid, wet and peaty islands of Lewis and Harris in the Outer Hebrides.

Essentially similar vegetation occurs in the uplands of Ireland. Although bracken is cosmopolitan it rarely forms the dense stands characteristic of the *Pteridium-Galium* community in the more continental climate of mainland Europe (Rodwell 1992), where it is a plant of woodland clearings and margins. It can, however, form large stands in the Pyrenees (Angus MacDonald, pers. comm.).

### ***Cryptogramma crisper-Deschampsia flexuosa* community (U21)**

#### DESCRIPTION

This is typically rather open vegetation on scree or among boulders. In summer the crisp, ruffled, bright-green fronds of *Cryptogramma crisper* are conspicuous. The fern dies back in the winter, but the dead, red-brown tufts of old fronds are still distinctive. These tufts become bigger each year, eventually forming humus in which plants such as *Deschampsia flexuosa*, *Festuca ovina* and *Galium saxatile* become established.

#### DIFFERENTIATION FROM OTHER COMMUNITIES

The *Cryptogramma-Deschampsia* community can only be confused with *Cryptogramma-Athyrium* snow-bed U18. The snow-bed has more montane plants, such as *Athyrium distentifolium*, *Dryopteris oreades*, *Carex bigelowii*, *Alchemilla alpina* and *Saxifraga stellaris*, although *A. alpina* also grows in *Cryptogramma-Deschampsia* vegetation in the Lake District and on Skye. In addition, the bryophyte layer of *Cryptogramma-Athyrium* snow-bed is generally more species-rich than that in the *Cryptogramma-Deschampsia* community.

#### ECOLOGY

This is pioneer vegetation of open, rocky ground, usually on steep slopes at moderate altitudes. Like many ferns, *Cryptogramma crisper* cannot tolerate much frost or drought, so it grows in places where there is an equable, humid climate. However, the *Cryptogramma-Deschampsia* community can occur at altitudes of 900 m or more where there are suitable scree slopes, for example on Yr Wyddfa (Snowdon) in north Wales. The rocks are typically hard and acid, and the soil is rarely more than a discontinuous raw humus derived from the decaying fern fronds. *Cryptogramma* seems unable to colonise very fine and loose scree, but can be very common on more stable slopes. A fragmentary form of the community can develop on artificial habitats, such as dry-stone walls, bridges and old buildings (Rodwell 1992).

Grass-covered screes occur on which *Cryptogramma* grows as sparse tufts within a matrix of *Festuca-Agrostis-Galium* grassland U4. This suggests that *Cryptogramma-Deschampsia* vegetation may eventually be replaced by grassland as screes become stabilised and soil accumulates. However, in many places the community appears to be held as an arrested succession by sheep grazing, especially in north Wales and the Lake District.

#### DISTRIBUTION

The *Cryptogramma-Deschampsia* community is most common in north Wales and the Lake District, where it is especially associated with hard volcanic rocks. It also occurs on sedimentary rocks in the north Pennines, the Cheviot Hills and the Southern Uplands, and on volcanic and metamorphic rocks in the western Highlands and on Skye.

Related vegetation occurs in the mountains of central Europe and in parts of western Norway.

## 1.8. Swamp communities (S9-11, S19, S27)

### ***Carex rostrata* swamp (S9)**

#### DESCRIPTION

This vegetation type comprises tall, grey-green swards of *Carex rostrata* emerging from shallow water.

There are two sub-communities: one species-poor, the other more species-rich. The *Carex rostrata* sub-community S9a takes in stands where there is little or nothing more than *C. rostrata*. The *Menyanthes trifoliata*-*Equisetum fluviatile* sub-community S9b is usually not as tall and dense, and has a more varied array of associated species, the most common of which are *Equisetum fluviatile*, *Menyanthes trifoliata* and *Potentilla palustris*. *Potamogeton polygonifolius*, *Caltha palustris*, *Pedicularis palustris*, *Carex nigra* and *Ranunculus flammula* are also fairly common in this sub-community. On sunny days the reflection of the light from the water and the shining leaves of *P. polygonifolius* and *Caltha* can be almost dazzling.

#### DIFFERENTIATION FROM OTHER COMMUNITIES

The *Carex rostrata* sub-community can hardly be mistaken for any other type of vegetation. The more herb-rich *Menyanthes-Equisetum* sub-community can be confused with several other vegetation types: the *Carex-Calliergon* sub-community of *Carex-Calliergonella* mire M9b, the *Carex rostrata* sub-community of *Equisetum fluviatile* swamp S10b, the *Carex rostrata* sub-community of *Carex vesicaria* swamp S11c, and the *Carex-Equisetum* sub-community of *Carex-Potentilla* tall-herb fen S27a. These five vegetation types are very close to each other floristically, and can have similar amounts of *Carex rostrata*, *Menyanthes trifoliata* and *Potentilla palustris*. The *Carex-Calliergon* sub-community of *Carex-Calliergonella* mire is a sedge-mire or fen and typically has a carpet of bryophytes, such as *Calliergonella cuspidata* and *Calliergon giganteum*, whereas the other vegetation types are swamps with tall emergent plants amid floating mats of vegetation in which bryophytes are generally scarce. Although *C. rostrata* can be common in both *Equisetum fluviatile* swamp and *Carex vesicaria* swamp, it is subordinate to either *E. fluviatile* or *C. vesicaria*, whereas it is the most common species in *Carex rostrata* swamp. Some stands of the *Carex-Equisetum* sub-community of *Carex-Potentilla* tall-herb fen have a richer and more varied flora than even the most species-rich forms of *Carex rostrata* swamp, with *Carex vesicaria*, *C. aquatilis*, *Juncus acutiflorus* and bryophytes, such as *Brachythecium rutabulum*, *B. rivulare* and *Rhizomnium punctatum*, but where these species are absent it can be impossible to assign stands to one vegetation type or the other.

#### ECOLOGY

*Carex rostrata* swamp is a community of shallow acid water with a bottom of mud or peat rather than stones. The *Carex rostrata* sub-community can grow in water as deep as a metre or more, but the shorter herbs of the *Menyanthes-Equisetum* sub-community are restricted to water less than about 30 cm deep. Most stands are below 600 m. They are usually small, covering only a few square metres at the edges of sheltered lochans, in deeper bog pools, in seepage channels in blanket bogs, and in the slow-moving deeper reaches of streams.

#### DISTRIBUTION

*Carex rostrata* swamp is widespread in upland regions and some adjacent lowland areas. It is absent from most of southern and eastern England.

There is similar vegetation in western Ireland (Horsfield *et al.* 1991).

### ***Equisetum fluviatile* swamp (S10)**

#### DESCRIPTION

These are swamps in which the thin grey stems of *Equisetum fluviatile*, rustled by the wind and reflected in the water, stand over an open, species-poor assemblage of plants.

There are two sub-communities. The species-poor *Equisetum fluviatile* sub-community S10a includes pure stands of *E. fluviatile* in Scottish lochs, as well as examples from periodically inundated places in the lowlands with species such as *Persicaria hydropiper*, *P. amphibia*, *Rorippa islandica* and *Ranunculus flammula*. The richer *Carex rostrata* sub-community S10b is a more mixed form of *Equisetum* swamp with *Carex rostrata*, *Menyanthes trifoliata*, *Potentilla palustris*, *Galium palustre* and other plants.

#### DIFFERENTIATION FROM OTHER COMMUNITIES

The *Equisetum* sub-community is distinctive, but the more species-rich *Carex rostrata* sub-community can resemble various other forms of swamp. It can be separated from the *Menyanthes-Equisetum* sub-community of *Carex rostrata* swamp S9b and the *Carex rostrata* sub-community of *Carex vesicaria* swamp S11c because there is more *Equisetum fluviatile* than either *Carex rostrata* or *C. vesicaria*. The flora of the *Carex rostrata* sub-community overlaps with that of the *Carex-Equisetum* sub-community of *Carex-Potentilla* tall-herb fen S27a, and the two vegetation types can share *E. fluviatile*, *C. rostrata*, *Menyanthes trifoliata* and *Potentilla palustris*. The richer forms of *Carex-Potentilla* tall-herb fen are distinctive, but it is not always possible to assign stands of vegetation to a particular NVC type.

#### ECOLOGY

This is a community of open water in lochs, peaty pools, water tracks through bogs, and slow-moving streams; stands of the *Equisetum* sub-community can grow in water more than a metre deep, and can extend into deeper water than *Carex rostrata* swamp. The bottom is usually peat, mud or silt rather than stones, and the water chemistry varies from acid to basic. Most stands occur at altitudes below 600 m.

#### DISTRIBUTION

There are *Equisetum fluviatile* swamps throughout the uplands from south-west England to northern Scotland. They also occur in lowland Britain.

Swamps dominated by *E. fluviatile* occur widely but locally in mainland Europe.

### ***Carex vesicaria* swamp (S11)**

#### DESCRIPTION

This form of swamp is dominated by tall tussocks of *Carex vesicaria*. The stout, yellow-green shoots of the sedge grow in conspicuous swards which stand out prominently from the surrounding vegetation.

There are three sub-communities. The *Carex vesicaria* sub-community S11a includes pure stands of *C. vesicaria*, and species-poor swards with a scattering of other plants, such as *Myosotis scorpioides* and *Persicaria amphibia*. The *Mentha aquatica* sub-community S11b is a more lowland form of swamp with *Galium palustre*, *Equisetum fluviatile*, *Mentha aquatica*, *Juncus effusus*, and in some places tall mesotrophic forbs, such as *Filipendula ulmaria*, *Veronica scutellata*, *Lythrum salicaria* and *Angelica sylvestris*. The *Carex rostrata* sub-community S11c is a more upland type with *Carex rostrata*, *Menyanthes trifoliata* and *Potentilla palustris*.

#### DIFFERENTIATION FROM OTHER COMMUNITIES

The *Carex vesicaria* sub-community is distinctive as there are no other swamps in which *Carex vesicaria* forms almost pure stands. The other two sub-communities can resemble the *Carex-Equisetum* sub-community of *Carex-Potentilla* tall-herb fen S27a, which can be dominated by *C. vesicaria*. *Mentha aquatica*, *Juncus effusus*, *Myosotis scorpioides*, *Filipendula ulmaria*, *Phalaris arundinacea* and *Veronica scutellata* are more common in the *Mentha* sub-community of *Carex vesicaria* swamp. However, the *Carex rostrata* sub-community of *Carex vesicaria* swamp and the *Carex-Equisetum* sub-community of *Carex-Potentilla* tall-herb fen share so many species that some stands could be equally well assigned to either vegetation type.

#### ECOLOGY

Most *Carex vesicaria* swamps are in shallow standing water, but they can also occur on wet ground that is only periodically flooded.

#### DISTRIBUTION

The community is widespread but rare, occurring from south Wales northwards. It is most common in Scotland.

*Carex vesicaria* swamps occur locally in parts of Scandinavia.

### ***Eleocharis palustris* swamp (S19)**

#### DESCRIPTION

*Eleocharis palustris* grows here in an even sward up to about 60 cm high. The dense, vivid green patches of *E. palustris* can be a conspicuous component of mixtures of mires and swamps in wet upland habitats.

There are three sub-communities, each defined by an almost mutually exclusive assemblage of species. The *Eleocharis palustris* sub-community S19a is the most species-poor form, but there can be a little *Alisma plantago-aquatica*, *Mentha aquatica* and *Myosotis laxa* ssp. *cespitosa*. The *Littorella uniflora* sub-community S19b takes in more upland stands of vegetation, containing species such as *Littorella uniflora*, *Equisetum fluviatile*, *Juncus bulbosus*, and, more locally, *Lobelia dortmanna* and *Potamogeton natans*. The *Agrostis stolonifera* sub-community S19c is a maritime form, and is characterised by *Agrostis stolonifera*, *Potentilla anserina*, *Glaux maritima*, *Triglochin maritima* and *Juncus gerardii*.

#### DIFFERENTIATION FROM OTHER COMMUNITIES

This is a distinct community. The dense swards of *Eleocharis palustris* are not likely to be confused with any other NVC type.

#### ECOLOGY

*Eleocharis palustris* swamp occurs in shallow water up to about 50 cm deep, in lochans, small pools, flushed channels and shallow streams. The *Agrostis* sub-community is known only from salt-marshes. Most stands of the community are below 600 m.

#### DISTRIBUTION

This community is widespread in Britain, occurring in both upland and lowland situations. In the uplands, the *Littorella* sub-community is the most usual form. The other two sub-communities are predominantly lowland, and the *Agrostis* sub-community is strictly coastal.

Similar types of swamp vegetation occur widely in western parts of mainland Europe.

### ***Carex rostrata*-*Potentilla palustris* tall-herb fen (S27)**

#### DESCRIPTION

These are herb-rich fens in which the thin, grey-green sward of *Carex rostrata* is mixed with tall or mat-forming mesotrophic herbs in lush stands which can contrast markedly with the surrounding heaths, bogs, rush-mires or sedge-mires. *Galium palustre*, *Menyanthes trifoliata* and *Potentilla palustris* are the most common associated herbs.

The two sub-communities distinguish vegetation dominated by *C. rostrata* from tall-herb fens in which dominance is shared by other species. The *Carex rostrata*-*Equisetum fluviatile* sub-community S27a is usually species-poor. Here, *C. rostrata* is accompanied by *E. fluviatile*, *Caltha palustris*, *Potamogeton polygonifolius*, *Juncus effusus* and *Ranunculus flammula*; *Carex vesicaria*, *C. aquatilis* and *Mentha aquatica* occur in some stands. The *Lysimachia vulgaris* sub-community S27b is more species-rich, including, in addition to the characteristic species of the *Carex*-*Equisetum* sub-community, *Angelica sylvestris*, *Phragmites australis*, *Carex nigra*, *Lychnis flos-cuculi*, *Iris pseudacorus* and *Filipendula ulmaria*. *Phragmites*, *C. nigra*, *J. effusus* or *Eriophorum angustifolium* usually dominate the sward in place of *C. rostrata*. Stands intermediate between the two sub-communities can be found in the uplands.

#### DIFFERENTIATION FROM OTHER COMMUNITIES

The herb-rich swards of the *Lysimachia* sub-community are quite distinctive, especially where *Carex rostrata* is not solely dominant. The *Carex*-*Equisetum* sub-community and stands intermediate between the two sub-communities include vegetation characterised by *C. rostrata*, *Menyanthes trifoliata* and *Potentilla palustris* growing with a wide range of other herbs, and with a few bryophytes, such as *Calliergonella cuspidata*, *Calliergon giganteum* and *Brachythecium rutabulum*. As such, the vegetation encompasses the floristic range of several other upland mires, fens and swamps: the *Menyanthes*-*Equisetum* sub-community of *Carex rostrata* swamp S9b, the *Carex rostrata* sub-community of *Equisetum fluviatile* swamp S10b, the *Carex rostrata* sub-community of *Carex vesicaria* swamp S11c, and the *Carex*-*Calliergon* sub-community of *Carex*-*Calliergonella* mire M9b. These vegetation types have so much in common that some stands could equally well be assigned to more than one type.

#### ECOLOGY

In the uplands, *Carex*-*Potentilla* tall-herb fen occurs around the margins of lochs and in pools and seepage lines within stands of blanket bog, rush-mire and sedge-mire. Most stands are at altitudes below about 300 m.

#### DISTRIBUTION

*Carex-Potentilla* tall-herb fen is widespread in the uplands and lowlands of Wales, northern England and Scotland. It is also common in East Anglia.

Similar vegetation occurs widely in mainland Europe, especially in parts of Norway.

## 1.9. Open vegetation communities (OV37-40)

### ***Festuca ovina-Minuartia verna* community (OV37)**

#### DESCRIPTION

This is open, grassy vegetation of metalliferous soils. It usually looks distinctively sparse from a distance, standing out from the denser surrounding swards. The short, patchy turf of *Festuca ovina* and *Agrostis capillaris* is intermixed with low mats of *Thymus polytrichus*, and is dotted with the small, white, starry flowers of the metallophyte *Minuartia verna* which enliven the drab greyish vegetation in early summer. *Thlaspi caerulescens*, another characteristic plant of metalliferous soils, can also be locally common. There are usually a few other small herbs, such as *Campanula rotundifolia*, *Rumex acetosa*, *R. acetosella* and *Linum catharticum*.

There are three sub-communities. The Typical sub-community OV37a has no special distinguishing species except that *Festuca rubra* is common in some stands. The *Achillea millefolium-Euphrasia officinalis* agg. sub-community OV37b has a thicker sward including *Achillea millefolium*, *Euphrasia officinalis* agg., *Anthoxanthum odoratum*, *Plantago lanceolata*, *Trifolium repens*, *Lotus corniculatus* and *Rhytidiadelphus squarrosus*. The *Cladonia* species sub-community OV37c resembles the Typical sub-community but has more lichens; the most common species are *Cladonia rangiformis*, *C. chlorophaea*, *C. pyxidata*, *C. portentosa* and *Coelocaulon aculeatum*. There can be a little *Calluna vulgaris* here too.

On gravelly serpentine debris in Shetland and the eastern Highlands there are related assemblages of very open vegetation with scattered *M. verna* or variable mixtures of *Arenaria norvegica*, *Cerastium alpinum*, *C. nigrescens*, *C. fontanum* ssp. *scotica*, *Lychnis alpina*, *Cochlearia micacea*, *Silene uniflora*, *Anthyllis vulneraria* and *Arabis petraea*. These are not included in the NVC (see p xxx).

#### DIFFERENTIATION FROM OTHER COMMUNITIES

The most distinctive plants of the *Festuca-Minuartia* community are *Minuartia verna* and *Thlaspi caerulescens*, both of which can tolerate high concentrations of heavy metals. The presence of these species, and the scarcity of *Potentilla erecta*, is generally sufficient to distinguish the community from swards of *Festuca-Agrostis-Thymus* grassland CG10. Other metal-tolerant species, such as *Armeria maritima*, *Cochlearia pyrenaica*, *Botrychium lunaria* and *Viola lutea*, are also characteristic of the *Festuca-Minuartia* community.

#### ECOLOGY

*Festuca-Minuartia* vegetation occurs on fragmentary mineral soils and gravelly debris with a high concentration of heavy metals. It is the characteristic community of waste from lead mines and outcrops of metalliferous rock. It also occurs on metal-enriched river shingles and alluvium in the northern and central Pennines (Richard Jefferson, pers. comm.). Lead and more particularly zinc occur here in amounts that are toxic to most plants, which is why the vegetation is sparse and open.

#### DISTRIBUTION

The *Festuca-Minuartia* community has been recorded on the spoil of lead mines and on veins of metalliferous rock within the Carboniferous limestone in the Pennines, Derbyshire, north-east Wales and the Mendip Hills. It also occurs on the waste of copper mines in Snowdonia, and has been recorded on the Ayrshire coast. Related vegetation occurs on serpentine in Scotland (see p xxx).

Similar forms of vegetation are known from Ireland and mainland Europe.

### ***Gymnocarpium robertianum-Arrhenatherum elatius* community (OV38)**

#### DESCRIPTION

The *Gymnocarpium-Arrhenatherum* community is a distinctive assemblage of plants, which occurs on limestone pavement and scree in the south of Britain. The triangular, grey-green fronds of *Gymnocarpium robertianum* are interleaved with the grasses *Arrhenatherum elatius*, *Festuca rubra*, *F. ovina*, *Brachypodium sylvaticum* and, in northern England, *Sesleria caerulea*. Also common here are lush shoots of *Mercurialis perennis*, *Teucrium scorodonia* and *Mycelis muralis*, and fragrant, reddish-green, lacy leaves of *Geranium robertianum*. The mosses *Homalothecium sericeum* and *Ctenidium molluscum* cling to the rock, and *Dicranum scoparium* grows in thick tufts among the vascular plants.

#### DIFFERENTIATION FROM OTHER COMMUNITIES

Stands of the *Gymnocarpium-Arrhenatherum* community containing much *Sesleria* might be confused with *Sesleria-Galium* grassland CG9, which can occur as fragments over rocky ground. However, *Gymnocarpium robertianum*, *Geranium robertianum*, *Arrhenatherum elatius*, *Mercurialis perennis* and *Mycelis muralis* are all rare in *Sesleria-Galium* grassland. *Arrhenatherum-Filipendula* grassland MG2 shares *Arrhenatherum* and *M. perennis* with the *Gymnocarpium-Arrhenatherum* community, but also has species of damp ground, such as *Filipendula ulmaria*, *Geum rivale* and *Valeriana officinalis*, and lacks *Gymnocarpium*. The *Asplenium-Cystopteris* crevice community OV40 can resemble stands of *Gymnocarpium-Arrhenatherum* vegetation containing the ferns *Asplenium viride* and *Cystopteris fragilis*, but can be distinguished by the scarcity of *Gymnocarpium* and tall grasses.

#### ECOLOGY

*Gymnocarpium-Arrhenatherum* vegetation occurs in the crevices or grikes of limestone pavement and on limestone scree. The soils are coarse-grained, fragmentary accumulations of humus and limestone gravel in the cracks between the stones. Neither *Gymnocarpium* nor *Arrhenatherum* can tolerate shade, and so this is a community of sunny, open ground. It rarely occurs more than a few hundred metres above sea-level.

#### DISTRIBUTION

Within the upland regions of Britain, *Gymnocarpium-Arrhenatherum* vegetation occurs on limestone pavement and limestone scree in the Yorkshire Dales and in Wales. It is also in the lowlands around Morecambe Bay, in Derbyshire and on the Mendips in south-west England.

There is similar vegetation in mainland Europe.

### ***Asplenium trichomanes-Asplenium ruta-muraria* community (OV39)**

#### DESCRIPTION

This community comprises colonies of small ferns on base-rich cliffs and walls. The most common species are *Asplenium trichomanes*, *A. ruta-muraria*, and the bryophytes *Homalothecium sericeum* and *Porella platyphylla*.

There are two sub-communities. In the *Trichostomum crispulum-Syntrichia intermedia* sub-community OV39a, *H. sericeum* and *P. platyphylla* are typically accompanied by a little *Neckera crispa*, *Targionia hypophylla* and a few crustose lichens. The more species-rich *Sedum acre-Arenaria serpyllifolia* sub-community OV39b has an array of small vascular plants including *Festuca ovina*, *Thymus polytrichus*, *Koeleria macrantha*, *Helianthemum nummularium*, *Sedum acre* and *Arenaria serpyllifolia*.

#### DIFFERENTIATION FROM OTHER COMMUNITIES

The *Asplenium trichomanes-Asplenium ruta-muraria* community can be confused only with the *Asplenium-Cystopteris* community OV40, a related form of rock crevice vegetation in which both *Asplenium trichomanes* and *A. ruta-muraria* also occur. They are easy to separate because *A. viride* and *Cystopteris fragilis* occur only in the *Asplenium-Cystopteris* community.

#### ECOLOGY

This is a community of crevices in basic rocks, such as limestone and basalt, and of mortared walls at low to moderate altitudes. On walls the plants grow in mortar, but in more natural rocky habitats the soils are patchy, with thin accumulations of humus and sand forming a disintegrating substrate.

#### DISTRIBUTION

The *Asplenium trichomanes-Asplenium ruta-muraria* community is widespread in the west of Britain from south-west England to northern Scotland but has not been thoroughly studied. It is certainly more common than is indicated by the distribution map.

There is similar vegetation elsewhere in Europe.

### ***Asplenium viride-Cystopteris fragilis* community (OV40)**

#### DESCRIPTION

This is a community of small ferns, herbs and mosses in rocky habitats. The main species are *Asplenium viride* with its bright-green fronds and the delicate, pale-grey-green *Cystopteris fragilis*. *Asplenium ruta-muraria* and *A. trichomanes* grow here too, together with a few small herbs, such as *Festuca ovina*, *Campanula rotundifolia*, *Thymus polytrichus* and *Hieracium* species. Bryophytes are common, including *Ctenidium molluscum*, *Tortella*

*tortuosa*, *Fissidens dubius*, *Neckera crispa* and *Homalothecium sericeum*. Where the community occurs on limestone pavement there can be much *Phyllitis scolopendrium* and *Polystichum aculeatum*.

#### DIFFERENTIATION FROM OTHER COMMUNITIES

*Asplenium-Cystopteris* vegetation may be confused with the other crevice community in which ferns dominate: the *Asplenium trichomanes-Asplenium ruta-muraria* community OV39. However, it can generally be distinguished by the presence of *Cystopteris fragilis* and *Asplenium viride*.

#### ECOLOGY

The *Asplenium-Cystopteris* community occurs in crevices in cliffs of base-rich rock, in the shallower grikes in limestone pavement, and more rarely in base-rich screes. Its habitat is similar to that of the *Asplenium trichomanes-Asplenium ruta-muraria* community, but it is characteristic of places where the microclimate is damper, more sheltered and more shaded. Although it occurs just above sea-level on Skye it ascends well into the montane zone above 600 m on mica-schist ledges on the hills of the central Highlands. The soils are fragmentary accumulations of gravel and humus: the ferns root deep into the rock crevices and gain access to water far below the surface.

#### DISTRIBUTION

*Asplenium-Cystopteris* vegetation is locally common on base-rich rocks in Scotland, the Lake District, the Pennines and Wales. There are particularly good examples on the Craven Pennine hills of Ingleborough, Pen-y-Ghent and Wherside, and on many of the Breadalbane cliffs. It also occurs in the lowlands in the Peak District of Derbyshire (not shown on the distribution map).

Similar rock crevice vegetation is known from Scandinavia and mainland Europe.

## 2. KEYS

### 2.1. Key to woodlands

Vegetation dominated by trees, including *Salix pentandra* and *S. cinerea*

- 1 Coniferous woodlands 2  
Deciduous woodlands 6
- 2 Pine woods 3  
Planted woods of exotic conifers, such as Sitka spruce, Norway spruce or larch 3  
Coniferous plantation
- 3 Pine woods with a heathy field layer 4  
Pine woods with a grassy or very sparse and species-poor ground flora 5
- 4 Native pine woods or old and open plantations, with a heathy field layer of *Calluna vulgaris* and/or *Vaccinium* species, and commonly with a luxuriant layer of bryophytes 4  
***Pinus sylvestris*-*Hylocomium splendens* woodland W18**  
Native pine woods or old and open plantations, with a short heathy field layer of *Calluna vulgaris* and *Erica cinerea* conspicuously and thickly mingled with lichens 4  
**Lichen-rich pinewoods (see W18)**
- 5 Obviously native pine woods (trees uneven-aged and scattered rather than in straight lines) on peaty soils and with a field layer dominated by *Molinia caerulea* 5  
**Pine woods with *Molinia* (see W18)**  
Dense or more open woods of obviously planted trees, usually even-aged and in straight lines, and with ground vegetation of common grasses and mosses or a sparsely-vegetated woodland floor littered with fallen needles 5  
Pine plantation
- 6 Woodland with a field layer dominated by forbs, sedges, *Brachypodium sylvaticum*, *Deschampsia cespitosa* or *Phragmites australis* rather than other grasses or dwarf shrubs 7  
Woodland with a field layer dominated by dwarf shrubs, grasses (except *Brachypodium sylvaticum*, *Deschampsia cespitosa* or *Phragmites australis*), bracken, bryophytes or *Luzula sylvatica* 13
- 7 Herb-rich woodland on damp or dry soils with *Mercurialis perennis*, *Brachypodium sylvaticum*, *Deschampsia cespitosa*, *Viola riviniana*, *Dryopteris filix-mas* and bryophytes, such as *Eurhynchium praelongum*, *E. striatum*, *Thuidium tamariscinum* and *Mnium hornum*; the canopy commonly includes ash, elm and hazel 8  
Herb-rich woodland on wet soils with at least one of *Filipendula ulmaria*, *Mentha aquatica*, *Galium palustre*, *Caltha palustris*, *Deschampsia cespitosa*, *Phragmites australis* and sedges common, and usually with much alder or willow in the canopy 9
- 8 Upland woodland with *Mercurialis perennis*, *Brachypodium sylvaticum*, *Deschampsia cespitosa*, *Viola riviniana*, *Oxalis acetosella* and other woodland herbs, and abundant ferns and bryophytes; commonly under a canopy of ash, elm or hazel but birch and rowan are also common 9  
***Fraxinus excelsior*-*Sorbus aucuparia*-*Mercurialis perennis* woodland W9**  
Lowland woodland similar to *Fraxinus*-*Sorbus*-*Mercurialis* woodland W9 (see above) but birch, rowan, *Oxalis acetosella* and ferns scarce or absent, bryophytes rather sparse, and bramble can be common; the lowland counterpart of *Fraxinus*-*Sorbus*-*Mercurialis* woodland and can occur on low ground in upland areas 9  
***Fraxinus excelsior*-*Acer campestre*-*Mercurialis perennis* woodland W8**
- 9 Swampy woodlands with a tall dense field layer of *Carex paniculata* under a canopy usually of birch, willow or alder; on moderately base-rich peat in floodplains, wet glens and basins; widespread but scarce in the lowlands, and rare at low altitudes in upland areas 9  
***Alnus glutinosa*-*Carex paniculata* woodland W5**  
Wet or swampy woodlands with a field layer not dominated by *Carex paniculata* 10

- 10 Fen woodlands of willow or birch with *Phragmites australis* abundant or dominant in the field layer, either with woodland herbs or *Sphagna*; on very wet ground in floodplains, valley floors and basins; widespread but scarce in the lowlands, and rare at low altitudes in upland Britain  
*Salix cinerea*-*Betula pubescens*-*Phragmites australis* woodland W2  
Woodlands in which *Phragmites australis* is not abundant or dominant in the field layer  
11
- 11 Swampy woodland with *Carex rostrata*, other species of *Carex*, *Menyanthes trifoliata*, *Potentilla palustris*, *Caltha palustris*, *Filipendula ulmaria*, *Calliargon cordifolium* and *C. giganteum* under a canopy usually of willows and birch  
*Salix pentandra*-*Carex rostrata* woodland W3  
Wet woodland without these swamp species  
12
- 12 Wet woodland, commonly on flushed sloping ground, with *Filipendula ulmaria*, *Lysimachia nemorum*, *Deschampsia cespitosa*, *Athyrium filix-femina*, *Dryopteris dilatata* and mosses, such as *Eurhynchium praelongum*, *Brachythecium rivulare* and *Calliargonella cuspidata*; canopy of alder, ash, hazel, birch or willows  
*Alnus glutinosa*-*Fraxinus excelsior*-*Lysimachia nemorum* woodland W7  
Wet *Salix cinerea* woodland with field layer including *Galium palustre*, *Juncus effusus* and *Mentha aquatica*, and with little or no *Lysimachia nemorum*, *Deschampsia cespitosa* and *Athyrium filix-femina*; lowland species, such as *Hedera helix*, *Rubus fruticosus*, *Solanum dulcamara* and *Lycopus europaeus*, can occur; bryophytes generally sparse; lowland woodland of wet soils on level ground or gentle slopes on floodplains, by rivers and beside ponds  
*Salix cinerea*-*Galium palustre* woodland W1
- 13 Woodland with a field layer dominated by *Luzula sylvatica*  
**Woodland with a field layer of *Luzula sylvatica*; can be too species-poor to classify to NVC type but see *Quercus-Betula-Oxalis* woodland W11 and *Quercus-Betula-Dicranum* woodland W17**  
Woodland with a field layer dominated by dwarf shrubs, grasses, bracken or bryophytes but not by *Luzula sylvatica*  
14
- 14 Heathy woodlands with *Vaccinium myrtillus*, *Calluna vulgaris* and/or conspicuously extensive and diverse carpets of bryophytes over most available substrates; grassy forms, usually with much *Deschampsia flexuosa*, still have abundant and varied bryophytes; forbs not very common; commonly on steep rocky ground with thin acid soils; canopy usually of birch and/or oak  
*Quercus petraea*-*Betula pubescens*-*Dicranum majus* woodland W17  
Grassy woodlands on slopes and level ground, usually without many rocks; although bryophytes can be common they do not form extensive mats over the ground, rocks and trees; small forbs can be very common  
15
- 15 Woodlands on wet peaty soils, with a species-poor flora of *Molinia caerulea*, *Juncus effusus*, *Sphagnum fallax*, *S. palustre* and *Polytrichum commune*, and a canopy usually of birch, willow or alder  
*Betula pubescens*-*Molinia caerulea* woodland W4  
Woodlands on well-drained slopes, with little or no *Molinia caerulea* and with a grassy field layer which can contain many small forbs; bracken can be very common  
16
- 16 Woodlands with a dense field layer of *Deschampsia flexuosa*, commonly growing in rounded tufts so that the woodland floor looks as if it is covered with a green quilt, under a canopy of oak, birch or beech  
17
- Woodlands where the field layer comprises mixtures of *Holcus lanatus*, *H. mollis*, *Anthoxanthum odoratum*, *Agrostis capillaris* and *Deschampsia flexuosa*; usually with many woodland forbs, such as *Oxalis acetosella*, *Primula vulgaris*, *Viola riviniana*, *Potentilla erecta* and *Hyacinthoides non-scripta*, much bracken and in some places bramble  
18
- 17 Species-poor woodlands on thin well-drained soils with a dense sward of *Deschampsia flexuosa* and in many places scattered bracken, under a canopy of oak and/or birch; not very mossy; the lowland counterpart of *Quercus-Betula-Dicranum* woodland W17; occurs on thin acid soils on some upland fringes  
*Quercus* species-*Betula* species-*Deschampsia flexuosa* woodland W16  
Woodlands with a species-poor field layer of *Deschampsia flexuosa* under a canopy of planted beech; widespread in the lowlands and rather scarce in the uplands  
*Fagus sylvatica*-*Deschampsia flexuosa* woodland W15

- 18 Woodlands on well-drained soils, with a grassy field layer of *Holcus lanatus*, *Agrostis capillaris*, *Anthoxanthum odoratum*, forbs such as *Oxalis acetosella*, *Viola riviniana*, *Potentilla erecta*, *Primula vulgaris* and *Hyacinthoides non-scripta*, and commonly with much bracken

***Quercus petraea*-*Betula pubescens*-*Oxalis acetosella* woodland W11**

Woodlands on well-drained soils, with a species-poor field layer usually dominated by *Holcus mollis*, bracken or bramble; *Anthoxanthum odoratum*, *Agrostis capillaris*, *Viola riviniana* and *Potentilla erecta* scarce or absent; the lowland counterpart of *Quercus-Betula*-*Oxalis* woodland W11 and can occur around upland fringes

***Quercus robur*-*Pteridium aquilinum*-*Rubus fruticosus* woodland W10**

## 2.2. Key to scrub

Vegetation dominated by *Crataegus monogyna*, *Prunus spinosa*, *Ulex europaeus*, *Cytisus scoparius*, *Juniperus communis* (except prostrate forms), *Salix aurita*, *S. arbuscula*, *S. lapponum*, *S. lanata*, *S. myrsinites*, *S. reticulata* or bramble

- 1 Scrub dominated by willows: *Salix aurita*, *S. arbuscula*, *S. lapponum*, *S. lanata*, *S. myrsinites* or *S. reticulata* 2  
 Scrub with a canopy of *Crataegus monogyna*, *Prunus spinosa*, *Ulex europaeus*, *Cytisus scoparius* or *Juniperus communis* ssp. *communis*, or underscrub of bramble 5
- 2 Scrub at moderate to high altitudes composed of montane willows (combinations of *Salix arbuscula*, *S. lapponum*, *S. lanata*, *S. myrsinites* and *S. reticulata*) and usually with a rich ground flora of tall herbs; usually on cliff ledges 3  
**Salix lapponum-Luzula sylvatica scrub W20**  
 Scrub at low to moderate altitudes, dominated by *Salix aurita* 3
- 3 Willow scrub on wet peaty soils, with a species-poor flora of *Molinia caerulea*, *Juncus effusus*, *Sphagnum fallax*, *S. palustre* and *Polytrichum commune* 4  
**Salix aurita scrub form of Betula pubescens-Molinia caerulea woodland W4**  
 Willow scrub with little or no *Molinia* and *Sphagnum*; forbs and sedges common 4
- 4 Swampy woodland with *Carex rostrata*, other species of *Carex*, *Menyanthes trifoliata*, *Potentilla palustris*, *Caltha palustris*, *Filipendula ulmaria*, *Calliergon cordifolium* and *C. giganteum* 5  
**Salix aurita scrub form of Salix pentandra-Carex rostrata woodland W3**  
 Wet woodland, commonly on flushed sloping ground, with *Filipendula ulmaria*, *Lysimachia nemorum*, *Deschampsia cespitosa*, *Athyrium filix-femina*, *Dryopteris dilatata* and mosses, such as *Eurhynchium praelongum*, *Brachythecium rivulare* and *Calliergonella cuspidata* 6  
**Salix aurita scrub form of Alnus glutinosa-Fraxinus excelsior-Lysimachia nemorum woodland W7**
- 5 Scrub dominated by *Juniperus communis* ssp. *communis* with a heathy or grassy field layer 7  
**Juniperus communis ssp. communis-Oxalis acetosella woodland W19**  
 Scrub dominated by other species 6
- 6 Tall scrub dominated by *Crataegus monogyna* or *Prunus spinosa* 7  
 Scrub dominated by *Ulex europaeus*, *Cytisus scoparius* or *Rubus fruticosus* 8
- 7 Scrub dominated by *Crataegus monogyna*, commonly over a mixture of forbs, bramble and ivy; common in the lowlands and can occur at low altitudes in the uplands 9  
**Crataegus monogyna-Hedera helix scrub W21**  
 Prickly and in many places impenetrable scrub dominated by *Prunus spinosa*, usually with sparse ground vegetation of forbs and in some places bramble or ivy; common in the lowlands and can occur at low altitudes in upland areas, for example near the sea in the west Highlands and Inner Hebrides 10  
**Prunus spinosa-Rubus fruticosus scrub W22**
- 8 Scrub dominated by *Ulex europaeus* and/or *Cytisus scoparius*, with a grassy field layer or, in dense stands, with very little vegetation beneath the shrubs 11  
**Ulex europaeus-Rubus fruticosus scrub W23**  
 Scrub dominated by *Rubus fruticosus* 9
- 9 *Rubus fruticosus* scrub with some *Holcus lanatus*, *Dactylis glomerata*, *Arrhenatherum elatius* and forbs on disturbed and abandoned ground at low altitudes in upland areas, especially around old buildings and at roadsides 12  
**Rubus fruticosus-Holcus lanatus underscrub W24**  
*Rubus fruticosus* scrub with much bracken and in many places *Rubus idaeus*, *Rosa canina* and some woodland species, such as *Hyacinthoides non-scripta* and *Teucrium scorodonia* 13  
**Pteridium aquilinum-Rubus fruticosus underscrub W25**

## 2.3. Key to dwarf-shrub heaths

Vegetation dominated by *Calluna vulgaris*, *Vaccinium* species, *Erica* species, *Arctostaphylos* species, *Empetrum nigrum*, *Ulex gallii*, prostrate *Juniperus communis* or *Dryas octopetala*

- 1 Heaths in which *Dryas octopetala* is abundant or dominant 2  
Heaths dominated by other shrubs: *Calluna vulgaris*, *Vaccinium* species, *Ulex gallii*, *Empetrum nigrum*, *Erica* species, *Arctostaphylos* species or prostrate *Juniperus communis* 3
- 2 Heaths of *Dryas octopetala* and in some places also *Arctostaphylos uva-ursi* and *Empetrum nigrum*, with *Thymus polytrichus*, sedges, such as *Carex flacca* and *C. panicea*, and a variety of small calcicolous forbs; at low altitudes on limestone and less commonly on other base-rich rocks (e.g. basalt) or on shell-sand 3  
***Dryas octopetala-Carex flacca* heath CG13**  
Heaths with *Dryas* and a rich array of montane calcicoles and mesotrophic forbs, such as *Silene acaulis*, *Saxifraga aizoides*, *S. oppositifolia*, *Carex capillaris*, *Persicaria vivipara* and *Alchemilla alpina*, on ungrazed ledges at moderate to high altitudes, on mica-schist or similarly base-rich rocks 3  
***Dryas octopetala-Silene acaulis* ledge community CG14**
- 3 Wet heaths with a patchy variegated brown and ochre canopy of *Calluna vulgaris*, *Erica tetralix*, *Molinia caerulea*, *Trichophorum cespitosum* and, in south-west England and south Wales, *Ulex gallii* and *Agrostis curtisii*; *Sphagnum capillifolium*, *S. denticulatum* or *S. compactum* are common but *S. papillosum* is generally rare; *Eriophorum angustifolium* is common but *E. vaginatum* is absent or scarce; on shallow but wet peat; if *S. papillosum* and/or *E. vaginatum* are common, see key to blanket, raised and valley mires (p xx) 4  
Dry or damp heaths dominated by ericoid shrubs, *Empetrum nigrum*, prostrate *Juniperus communis* or *Ulex gallii*, locally with much *Sphagnum capillifolium* but with little or no *Molinia caerulea*, *Erica tetralix* and *Trichophorum cespitosum*; on well-drained mineral soils or shallow humic soils over scree; in some places on dry peat but then lacking any bog species 6
- 4 Heaths with *Calluna vulgaris*, *Ulex gallii*, *Erica cinerea*, *E. tetralix*, *Molinia caerulea*, *Trichophorum cespitosum* and *Agrostis curtisii*; on wet peat or damp mineral soils up to about 500 m; only in south-west England and south Wales 6  
***Ulex gallii-Agrostis curtisii* heath H4**  
Wet heaths in which *Ulex gallii* and *Agrostis curtisii* are scarce or absent 5
- 5 Wet heaths with an uneven patchy sward of *Calluna vulgaris*, *Erica tetralix*, *Molinia caerulea* and *Trichophorum cespitosum*, commonly with scattered shoots of *Narthecium ossifragum* and *Eriophorum angustifolium*; varies from tall swards co-dominated by *Calluna* and *Molinia* to shorter and more open swards with much *Erica cinerea* and *Racomitrium lanuginosum*; in the far north these shorter forms can have a noticeable white frosting of *Cladonia* lichens, and locally in the far north-west Highlands they can contain *Juniperus communis* ssp. *nana*; some stands contain scattered *Vaccinium myrtillus*, and others are dominated by *Trichophorum cespitosum* with very sparse dwarf shrubs and few other species 6  
***Trichophorum cespitosum-Erica tetralix* wet heath M15**  
Wet heaths with much *Sphagnum compactum* under an even mixed sward of *Calluna* and *Erica tetralix* with sparse graminoids 6  
***Erica tetralix-Sphagnum compactum* wet heath M16**
- 6 Heaths dominated by *Ulex gallii* with little or no *Calluna vulgaris* 6  
***Ulex*-dominated form of *Calluna vulgaris-Ulex gallii* heath H8**  
Dry heaths dominated by *Calluna vulgaris*, *Vaccinium* species, *Arctostaphylos* species or *Empetrum nigrum*; *Ulex gallii* may be co-dominant with *Calluna* but not the sole dominant 7
- 7 Dry heaths dominated by *Vaccinium myrtillus* or more rarely *V. vitis-idaea* or *Empetrum nigrum* with little or no *Calluna vulgaris*, appearing green from a distance 8  
Heaths in which *Calluna vulgaris* is either dominant or at least co-dominant with other dwarf shrubs, such as *Vaccinium myrtillus*, *Erica cinerea*, *Arctostaphylos uva-ursi*, *Juniperus communis* ssp. *nana* or *Ulex gallii*, appearing dark from a distance when the shrubs are not in flower, and with a rich purple hue in late summer when the heather is flowering 12

- 8 Sub-montane heaths of *Vaccinium myrtillus* or more rarely *V. vitis-idaea* or *Empetrum nigrum* ssp. *nigrum*, with species such as *Deschampsia flexuosa* and *Potentilla erecta*; can have a thick underlay of mosses (including *Sphagnum capillifolium*) but *Racomitrium lanuginosum* is not abundant, and montane species are rare  
**9**
- Montane heaths of short *Vaccinium myrtillus*, in many places with *V. vitis-idaea*, *V. uliginosum*, *Empetrum nigrum* ssp. *hermaphroditum*, *Diphasiastrum alpinum* and other montane species, with a ground layer of varied mixtures of large pleurocarpous mosses, *Racomitrium lanuginosum*, *Sphagnum capillifolium*, or large leafy liverworts or of *Cladonia* lichens  
**10**
- 9 *Vaccinium myrtillus*, *V. vitis-idaea* or *Empetrum nigrum* ssp. *nigrum* heaths with varying amounts of grasses and in some places *Alchemilla alpina*; commonly with a thick underlay of pleurocarpous mosses; *Cladonia* lichens may be common but montane species are absent  
**Vaccinium myrtillus-Deschampsia flexuosa heath H18**  
Damp heaths dominated by *Vaccinium myrtillus*, in some places with *V. vitis-idaea* or *Empetrum nigrum* ssp. *nigrum*, and with much *Sphagnum capillifolium* in extensive mats of bryophytes under the dwarf shrubs; on steep shaded slopes at moderate altitudes in north-west England, Wales, and southern Scotland  
**Vaccinium myrtillus-Sphagnum capillifolium damp heath (see H21)**
- 10 Montane heaths of *Vaccinium* spp. and *Empetrum nigrum* ssp. *hermaphroditum* with a conspicuous white ground layer of *Cladonia arbuscula* and other lichens such as *Cetraria islandica*  
**Vaccinium myrtillus-Cladonia arbuscula heath H19**  
Montane heaths of *Vaccinium myrtillus* and *Empetrum nigrum* ssp. *hermaphroditum* with a mossy ground layer dominated by large pleurocarpous mosses or *Racomitrium lanuginosum* together with varying amounts of *Sphagnum capillifolium* and large liverworts, but at most a thin scattering of lichens  
**11**
- 11 Mossy ground layer dominated by *Racomitrium lanuginosum*, in some places with *Sphagnum capillifolium*, large leafy liverworts and small quantities of large pleurocarpous mosses  
**Vaccinium myrtillus-Racomitrium lanuginosum heath H20**  
Mossy ground layer dominated by large pleurocarpous mosses and *Sphagnum capillifolium*; *Racomitrium lanuginosum* scarce  
**Vaccinium myrtillus-Rubus chamaemorus heath H22**
- 12 *Calluna vulgaris* and *Arctostaphylos uva-ursi* co-dominant on dry stony soils  
**Calluna vulgaris-Arctostaphylos uva-ursi heath H16**  
*Calluna vulgaris* dominant or mixed with *Vaccinium myrtillus*, *Erica cinerea* or *Ulex gallii*  
**13**
- 13 Mixed heaths of *Calluna vulgaris* and *Ulex gallii*  
**14**  
Heaths of *Calluna vulgaris* and other dwarf shrubs but not *Ulex gallii*  
**15**
- 14 Heaths with *Calluna vulgaris*, *Ulex gallii*, *Erica cinerea* and *Agrostis curtisii*; the community is a blaze of purple and gold in late summer when the shrubs are flowering; in south-west England and south Wales  
**Ulex gallii-Agrostis curtisii heath, Agrostis curtisii-Erica cinerea sub-community H4a**  
Heaths with *Calluna vulgaris* and *Ulex gallii* but no *Agrostis curtisii*; the rich golden flowers of *Ulex* are visible from afar and serve to distinguish these heaths from pure heather moorland in the summer when the shrubs are flowering; in the uplands of south-west England, throughout Wales, in northern England, and very rare in southern Scotland  
**Calluna vulgaris-Ulex gallii heath H8**
- 15 Sub-montane heaths with tall or at least erect *Calluna vulgaris* and no montane species, appearing dense and dark from a distance except when the heather is flowering in late summer  
**16**  
Montane heaths with *Calluna vulgaris* growing horizontally along the ground (prostrate) or severely stunted, commonly with montane species, such as *Cetraria islandica*, *Carex bigelowii* and *Diphasiastrum alpinum*; because the stems of the heather are exposed to view these heaths have a pale reddish-grey tinge quite different from the dark purple-brown of the taller, sub-montane heaths  
**21**
- 16 Mixed heaths of *Calluna vulgaris* and *Erica cinerea*; *Vaccinium myrtillus* scarce or absent  
**17**  
Mixed heaths of *Calluna vulgaris* and *Vaccinium myrtillus*, in some places with much *Empetrum nigrum* and/or *Vaccinium vitis-idaea*; if *Erica cinerea* occurs in quantity, *V. myrtillus* is also abundant  
**18**

- 17 Maritime heaths with *Calluna vulgaris*, *Festuca ovina*, *Erica cinerea*, *Thymus polytrichus*, *Plantago lanceolata* and maritime species, such as *Scilla verna*, *Armeria maritima* and *Plantago maritima*; on coastal slopes and cliffs  
*Calluna vulgaris*-*Scilla verna* heath H7  
*Calluna vulgaris* dominant or co-dominant with *Erica cinerea*; *Vaccinium myrtillus* scarce or absent; *Potentilla erecta* and *Carex binervis* common; the bright purple-pink flowers of *Erica cinerea* are conspicuous from midsummer onwards; commonly with abundant pleurocarpous mosses, in some places with grasses or a few small forbs, and in some other places with *Cladonia* lichens  
**Calluna vulgaris-Erica cinerea heath H10**
- 18 Damp heaths with abundant *Sphagnum capillifolium* as well as other bryophytes under a canopy of *Calluna vulgaris* and *Vaccinium* species; on humic rankers over scree or very shallow damp peat; can occur from a few metres above sea-level to well above the tree-line  
**19**  
Sub-montane heaths either dominated by *Calluna vulgaris* or co-dominated by *Calluna* and *Vaccinium myrtillus*; in some places with *Vaccinium vitis-idaea* but with neither *Sphagnum capillifolium* nor montane species  
**20**
- 19 Damp heaths with a canopy of *Calluna vulgaris* and smaller quantities of *Vaccinium myrtillus*, over a deep and usually extensive layer of mosses including *Sphagnum capillifolium*; *Racomitrium lanuginosum* can be common; in some places there are large mats and patches of leafy liverworts, such as the bright reddish-orange *Herbertus aduncus* ssp. *hutchinsiae*; where the liverworts are absent the *S. capillifolium* gives a deep red tinge to the moss layer; generally on steep and shaded slopes  
**Calluna vulgaris-Vaccinium myrtillus-Sphagnum capillifolium damp heath H21**  
Damp montane heaths with a short dense mixed canopy of *Calluna vulgaris* and *Vaccinium myrtillus* with much *Empetrum nigrum* ssp. *hermaphroditum* and a deep mossy layer of *Sphagnum capillifolium* mixed with *Rhytidiadelphus loreus*, *Hylocomium splendens*, *Dicranum scoparium* and *Pleurozium schreberi*; this mat of bryophytes has a distinctive golden-red colour from a distance; commonly dotted with *Rubus chamaemorus* and/or *Cornus suecica*; not confined to shaded slopes except in the south and east of the Highlands, where it occurs in sheltered hollows where snow obviously lies late  
**Vaccinium myrtillus-Rubus chamaemorus damp heath H22**
- 20 *Calluna vulgaris* dominant, in some places with a little *Vaccinium myrtillus* and/or *Deschampsia flexuosa*, or *Molinia caerulea*; dense species-poor heaths with some *Pohlia nutans* but without a deep layer of mosses  
**Calluna vulgaris-Deschampsia flexuosa heath H9**  
*Calluna vulgaris* abundant or dominant with much *Vaccinium myrtillus* in more varied heaths with a thick mat of large pleurocarpous mosses under the shrubs; in some places with abundant *Cladonia* lichens  
**Calluna vulgaris-Vaccinium myrtillus heath H12**
- 21 Montane heaths dominated by *Calluna vulgaris*, in some places with *Empetrum nigrum* ssp. *hermaphroditum*, *Erica cinerea* or *Vaccinium* species  
**22**  
Mixed heaths of *Calluna vulgaris*, *Juniperus communis* ssp. *nana* and *Arctostaphylos alpinus*  
**25**
- 22 Prostrate or severely dwarfed heaths of *Calluna vulgaris* and in some places *Empetrum nigrum*, *Erica cinerea* or *Vaccinium* species, the dwarf shrubs less than 5 cm tall and surrounded by dense silvery mats of *Racomitrium lanuginosum* with, at most, a scattering of lichens  
**23**  
Prostrate or severely dwarfed heaths of *Calluna vulgaris* and in some places *Empetrum nigrum*, *Erica cinerea* or *Vaccinium* species, either with a dense, continuous and conspicuous creamy-white mat of lichens around the dwarf shrubs or with a species-poor canopy of *Calluna* with neither lichens nor *Racomitrium lanuginosum*  
**24**
- 23 Short, open and grassy heaths, usually with dwarfed clumps of *Calluna vulgaris* in a matrix of *Nardus stricta* with much *Racomitrium lanuginosum* and species such as *Diphasiastrum alpinum*, *Huperzia selago*, *Carex bigelowii* and *C. pilulifera*; heaths look distinctively speckled pale and dark from a distance  
**Nardus stricta-Galium saxatile grassland, Racomitrium lanuginosum sub-community U5e**  
Heaths with a dense silvery-green mat of *Racomitrium lanuginosum* around the dwarf shrubs, and at most a scattering of lichens; *Nardus stricta* sparse or absent and *Calluna vulgaris* more continuous, giving a darker look to the vegetation; mainly in the western Highlands with outliers in Galloway and north Wales  
**Calluna vulgaris-Racomitrium lanuginosum heath H14**
- 24 Heaths with a creamy-white mat of *Cladonia arbuscula* and other lichens around the dwarf shrubs; in the central, eastern and northern Highlands, the Southern Uplands and the Lake District  
**Calluna vulgaris-Cladonia arbuscula heath H13**

Prostrate heaths dominated by *Calluna vulgaris*, in some places with small amounts of *Empetrum nigrum* or *Vaccinium* species; can have a few other species, such as *Carex pilulifera*, *Huperzia selago* or *Diphasiastrum alpinum*, but neither lichens nor *Racomitrium lanuginosum* are common

**Species-poor prostrate *Calluna vulgaris* heath (see H13 and H14)**

- 25 Mixed heaths of prostrate *Calluna vulgaris* and *Juniperus communis* ssp. *nana*, in some places with *Trichophorum cespitosum* and oceanic liverworts, such as *Pleurozia purpurea*; the shiny green clumps of juniper are conspicuous against the darker tones of the heather; on exposed stony ground at moderate to high altitudes in the western Highlands and the Hebrides, with fragmentary stands in the Lake District and north Wales

***Calluna vulgaris*-*Juniperus communis* ssp. *nana* heath H15**

Mixed prostrate heaths of *Calluna vulgaris*, *Arctostaphylos alpinus* and in many places *Loiseleuria procumbens* and *A. uva-ursi*; on stony ridges, moraines and gentle slopes at moderate to high altitudes in the north and north-west Highlands

***Calluna vulgaris*-*Arctostaphylos alpinus* heath H17**

## 2.4. Key to blanket, raised and valley mires

Vegetation on deep wet peat which receives most of its water from rain rather than from lateral flushing (except for valley mires)

- 1 Bog vegetation on deep but rarely saturated peat with much *Eriophorum vaginatum* growing in tussocks with *Calluna vulgaris*, *Vaccinium* species and/or *Empetrum nigrum*, and with a bryophyte layer containing abundant *Sphagnum capillifolium* but few other Sphagna; in some places a virtually pure sward of tussocky *E. vaginatum* **2**

Vegetation on deep and wet peat, usually with much *Sphagnum papillosum* as well as other Sphagna, and a mixed pale-coloured sward of species such as *Calluna vulgaris*, *Erica tetralix*, *Eriophorum vaginatum*, *E. angustifolium*, *Molinia caerulea*, *Trichophorum cespitosum*, *Myrica gale*, *Drosera* species and *Narthecium ossifragum* **3**

- 2 Dark reddish-green swards with tufted evenly-mixed *Calluna vulgaris* and *Eriophorum vaginatum*, together with *Vaccinium* species, *Empetrum nigrum* (which can replace *Calluna* in stands at high altitudes) and a rich moss layer of *Sphagnum capillifolium* and pleurocarpous mosses, such as *Hylocomium splendens*, *Rhytidiadelphus loreus*, *Pleurozium schreberi*, *Hypnum jutlandicum* and *Plagiothecium undulatum*; *Cladonia* lichens are very common in some northern and north-eastern stands

**Calluna vulgaris-Eriophorum vaginatum blanket mire M19**  
Pale swards dominated by dense tussocky *Eriophorum vaginatum*, commonly with a scattering of *Vaccinium* species, *Empetrum nigrum* and *Calluna vulgaris*; the moss flora is usually sparse but there can be some Sphagna, or much *Hypnum jutlandicum* or *Pleurozium schreberi*

**Eriophorum vaginatum blanket and raised mire M20**

- 3 Valley mires on deep saturated peat in valley floors and hollows, in some places containing a sluggish stream; the vegetation consists of extensive mats of *Sphagnum papillosum* with *S. denticulatum* or *S. fallax*, under a thin sward of *Narthecium ossifragum*, *Eriophorum angustifolium*, *Molinia caerulea*, *Erica tetralix* and *Calluna vulgaris*; without *Eriophorum vaginatum* or *Trichophorum cespitosum*; in the uplands, common only in south-west England, but with scattered occurrences as far north as the Pennines, Lake District and Scotland

**Narthecium ossifragum-Sphagnum papillosum valley mire M21**

Blanket, raised or less commonly valley mires with much *Eriophorum angustifolium*, *Trichophorum cespitosum* and dwarf shrubs; *Eriophorum vaginatum* usually present but can be sparse, especially in the far west Highlands and south-west England; abundant *Sphagnum papillosum* and *S. capillifolium* or *Racomitrium lanuginosum* **4**

- 4 Mires with extensive carpets of *Sphagnum papillosum*, *S. capillifolium* and in many places *S. magellanicum*, beneath an open canopy of *Eriophorum* species, *Trichophorum cespitosum*, *Calluna vulgaris* and *Erica tetralix*; other dwarf shrubs may be present, such as *Empetrum nigrum* and, more distinctively and locally, *Vaccinium oxycoccos* and *Andromeda polifolia*; *Molinia caerulea* is rare; *Cladonia* lichens are locally common; the carpet of Sphagna can be almost continuous, and shallow pools and hollows tend to be filled with *Sphagnum cuspidatum*, but on drier bogs Sphagna can be more patchy; the characteristic vegetation of lowland raised mires but can form blanket mires in the uplands, especially in mid Wales, northern England and Scotland

**Erica tetralix-Sphagnum papillosum raised and blanket mire M18**

Mires with much *Molinia caerulea*, *Trichophorum cespitosum*, *Eriophorum* species, *Myrica gale*, *Calluna vulgaris* and *Erica tetralix*; *Vaccinium oxycoccos* and *Andromeda polifolia* are rare or absent; Sphagna are usually no more abundant than vascular plants **5**

- 5 Blanket bogs with a light ochre-coloured sward of *Eriophorum* species, *Trichophorum cespitosum*, *Molinia caerulea*, *Calluna vulgaris*, *Erica tetralix*, *Myrica gale*, *Sphagnum papillosum*, *S. capillifolium* and *Potentilla erecta*; in some stands Sphagna are scarce and there is much *Racomitrium lanuginosum* forming carpets or conspicuous raised hummocks; *Pleurozia purpurea* and *Cladonia* lichens are very common in some Scottish stands; small patches of *Sphagnum cuspidatum*, *S. tenellum* and *S. denticulatum* can be common; extensive in the west Highlands, more local in the central and eastern Highlands, Galloway, Lake District, Wales and south-west England

**Trichophorum cespitosum-Eriophorum vaginatum blanket mire M17**

Flushed channels in blanket bogs and wet heaths with a sparse open sward of *Erica tetralix*, *Molinia caerulea*, *Trichophorum cespitosum*, *Eriophorum angustifolium* and *Carex* species over a varied and patchy lower layer of *Sphagnum denticulatum*, *Campylopus atrovirens*, *Breutelia chrysocoma* and *Narthecium ossifragum*; *Sphagnum papillosum* and *Eriophorum vaginatum* scarce or absent; *Schoenus nigricans* is common in some stands at low altitudes in the western Highlands

**Trichophorum cespitosum-Erica tetralix wet heath, Carex panicea sub-community M15a**

## 2.5. Key to grasslands

Vegetation dominated by grasses other than *Phragmites australis* and *Phalaris arundinacea*

- 1 Wet or damp grasslands dominated by *Molinia caerulea*, either with a scattering of dwarf shrubs, an array of other grasses, or tall mesotrophic forbs 2  
 Grasslands dominated by other species 8
- 2 Herb-rich *Molinia* grasslands with mesotrophic or basiphilous species, such as *Angelica sylvestris*, *Filipendula ulmaria*, *Geum rivale*, *Ranunculus acris*, *Succisa pratensis*, *Carex pulicaris*, *C. hostiana*, *Briza media*, *Cirsium palustre*, *C. dissectum*, *Lotus uliginosus*, *Mentha aquatica*, *Pulicaria dysenterica*, *Valeriana dioica*, *Crepis paludosa*, *Sanguisorba officinalis*, *Equisetum palustre* and *Calliergonella cuspidata* 3  
*Molinia* grasslands with dwarf shrubs or other grasses but few or none of the above mesotrophic or basiphilous species 6
- 3 *Molinia* grasslands, usually with two or more of *Carex pulicaris*, *C. hostiana*, *Briza media*, *Valeriana dioica*, *Cirsium dissectum*, *Crepis paludosa* and *Sanguisorba officinalis* common 4  
 Herb-rich *Molinia* grasslands with little or no *Briza media*, *Carex pulicaris*, *C. hostiana*, *Valeriana dioica*, *Cirsium dissectum*, *Crepis paludosa* and *Sanguisorba officinalis* 5
- 4 Herb-rich *Molinia* grasslands lacking *Crepis paludosa* and usually with *Cirsium dissectum*; widespread in lowland England and Wales, and also occurs on low ground in upland areas of England, Wales and parts of Scotland 4  
*Molinia caerulea*-*Cirsium dissectum* fen-meadow M24  
 Herb-rich *Molinia* grasslands without *Cirsium dissectum* but with much *Crepis paludosa* and in many places with *Sanguisorba officinalis*; scarce in southern Scotland, northern England and north Wales 5  
***Molinia caerulea*-*Crepis paludosa* mire M26**
- 5 Herb-rich *Molinia* grasslands with one or more of *Angelica sylvestris*, *Filipendula ulmaria*, *Geum rivale*, *Cirsium palustre*, *Lotus uliginosus*, *Mentha aquatica* and *Calliergonella cuspidata* common; grasses other than *Molinia* scarce 5  
***Molinia caerulea*-*Potentilla erecta* mire, *Angelica sylvestris* sub-community M25c**  
 Moderately herb-rich *Molinia* grasslands with some *Succisa pratensis*, *Lotus uliginosus*, *Rumex acetosa* or *Ranunculus acris*, but little or no *Angelica sylvestris*, *Filipendula ulmaria*, *Geum rivale*, *Cirsium palustre*, *Mentha aquatica* or *Calliergonella cuspidata*; grasses other than *Molinia* are common 6  
***Molinia caerulea*-*Potentilla erecta* mire, *Anthoxanthum odoratum* sub-community M25b**
- 6 Very species-poor swards of *Molinia caerulea* with little more than a few shoots of *Potentilla erecta*; locally extensive on wet hillsides and in valley bottoms, especially in Wales 6  
**Species-poor form of *Molinia caerulea*-*Potentilla erecta* mire M25**  
*Molinia caerulea* grasslands with *Potentilla erecta* and either a scattering of dwarf shrubs or an array of other grasses 7
- 7 Boggy *Molinia*-*Potentilla* grasslands with shrubs, such as *Calluna vulgaris*, *Erica tetralix* and *Myrica gale*, and commonly with other mire species, such as *Narthecium ossifragum* and *Sphagnum capillifolium*; common throughout the western uplands 7  
***Molinia caerulea*-*Potentilla erecta* mire, *Erica tetralix* sub-community M25a**  
 Drier *Molinia*-*Potentilla* grasslands with much *Holcus lanatus*, *Anthoxanthum odoratum*, *Agrostis capillaris* and *Festuca* species; can have a few forbs, such as *Succisa pratensis*, *Rumex acetosa* and *Ranunculus acris* 8  
***Molinia caerulea*-*Potentilla erecta* mire, *Anthoxanthum odoratum* sub-community M25b**
- 8 Grasslands dominated by *Deschampsia cespitosa* or *D. flexuosa* 9  
 Grasslands dominated by other species 13
- 9 *Deschampsia flexuosa* grasslands 10  
*Deschampsia cespitosa* grasslands 11

- 10 Sub-montane grasslands with tall swards of *Deschampsia flexuosa* mixed with *Calluna vulgaris*, *Galium saxatile* and *Potentilla erecta*  
**Deschampsia flexuosa grassland U2**  
Montane *Deschampsia flexuosa* grasslands on shaded slopes in high corries in the Cairngorms, with montane species, such as *Juncus trifidus*, *Huperzia selago* and *Polytrichum alpinum*  
**Salix herbacea-Racomitrium heterostichum snow-bed U12**
- 11 Wet lowland grasslands with a tall tussocky sward of *Deschampsia cespitosa*, *Holcus lanatus* and *Poa trivialis* mixed with other grasses and tall mesotrophic forbs; a grassland community which occurs locally at low altitudes in upland areas but its range does not overlap with that of the more montane *D. cespitosa* grasslands and it could hardly be confused with them  
*Holcus lanatus-Deschampsia cespitosa* grassland MG9  
Upland grasslands with a short tussocky sward of *Deschampsia cespitosa*; *Holcus lanatus* and *Poa trivialis* rare or absent; *Galium saxatile*, *Potentilla erecta* and *Festuca ovina*, or upland species, such as *Trollius europaeus* and *Geum rivale*, generally present  
**12**
- 12 Species-poor grasslands with *Deschampsia cespitosa*, *Galium saxatile*, *Festuca ovina*, *Potentilla erecta* and pleurocarpous mosses on flushed shaded slopes and below cliffs  
**Deschampsia cespitosa-Galium saxatile grassland, Anthoxanthum odoratum-Alchemilla alpina sub-community U13a**  
Lush species-rich *Deschampsia cespitosa* grasslands with abundant tall mesotrophic forbs, such as *Ranunculus acris*, *Trollius europaeus*, *Angelica sylvestris* and *Geum rivale*, and mosses, such as *Rhytidiadelphus loreus* and *R. squarrosus*; on ungrazed slopes below cliffs and on ledges; also occurs as grazed stands of *Deschampsia cespitosa* with tall forbs growing as dwarfed basal rosettes  
**Luzula sylvatica-Geum rivale tall-herb community, Agrostis capillaris-Rhytidiadelphus loreus sub-community U17c**
- 13 Grasslands dominated by *Nardus stricta*  
**14**  
Grasslands dominated by other species  
**15**
- 14 Sub-montane grasslands with *Nardus stricta*, *Potentilla erecta*, *Galium saxatile* and common pleurocarpous mosses; can be quite species-rich with mesotrophic herbs, such as *Ranunculus acris* and *Alchemilla glabra*; montane species rare or absent  
**Nardus stricta-Galium saxatile grassland U5**  
High-altitude *Nardus* grasslands with *Carex bigelowii* and other montane species, such as *Cetraria islandica*, *Vaccinium uliginosum* and *Diphasiastrum alpinum*, and commonly with *Trichophorum cespitosum*, *Alchemilla alpina* or *Racomitrium lanuginosum*; in sheltered hollows, gullies and corries where snow lies late in spring  
**Nardus stricta-Carex bigelowii grass-heath U7**
- 15 Grasslands dominated by *Sesleria caerulea*, with *Thymus polytrichus*, *Koeleria macrantha*, *Galium sternerii* and a range of other small calcicolous forbs; on limestone in northern England  
**Sesleria caerulea-Galium sternerii grassland CG9**  
Grasslands dominated by other species  
**16**
- 16 Grasslands dominated by *Arrhenatherum elatius* and/or *Dactylis glomerata*  
**17**  
Grasslands dominated by other species  
**19**
- 17 Open grasslands with large tussocks of *Arrhenatherum elatius* mixed with *Gymnocarpium robertianum*, *Geranium robertianum*, *Teucrium scorodonia* and *Festuca* species on limestone pavement and base-rich scree  
**Gymnocarpium robertianum-Arrhenatherum elatius community OV38**  
Denser grasslands with a thick sward of grasses and no *Gymnocarpium robertianum*  
**18**
- 18 Rank species-rich grasslands of *Arrhenatherum elatius*, with woodland species, such as *Heracleum sphondylium*, *Mercurialis perennis*, *Silene dioica* and *Dryopteris filix-mas*, together with plants of damp ground, such as *Filipendula ulmaria*, *Valeriana officinalis*, *Geum rivale* and *Angelica sylvestris*  
**Arrhenatherum elatius-Filipendula ulmaria tall-herb grassland MG2**  
Rank species-poor swards of *Arrhenatherum elatius* and/or *Dactylis glomerata*, with neither woodland species nor plants of damp ground; a lowland grassland type which can occur along field margins and roadsides at low altitudes in upland areas

- 19 Species-poor grasslands dominated by *Lolium perenne*, or co-dominated by *Lolium* and other grasses, such as *Cynosurus cristatus* and *Festuca rubra* 20  
 Grasslands dominated by other species 21
- 20 Bright green swards of *Lolium perenne*, *Cynosurus cristatus*, *Holcus lanatus* and *Festuca rubra*, with other species including *Trifolium repens* and *Cerastium fontanum*; in improved permanent pastures, on roadside verges and on lawns  
*Lolium perenne*-*Cynosurus cristatus* grassland MG6  
 Brilliant green and almost pure swards of *Lolium perenne*, with small quantities of other species, such as *Phleum pratense*, *Poa trivialis* and *Dactylis glomerata*, and commonly with much *Trifolium repens*; improved grasslands and leys, mostly in enclosed fields and generally mown for hay or silage  
*Lolium perenne* leys and related grasslands MG7
- 21 Grasslands with *Festuca ovina/vivipara*, *Agrostis capillaris*, *Thymus polytrichus* and a range of small forbs and bryophytes; the smell of the *Thymus* can be noticeable when walking in the vegetation, especially on warm still days 22  
 Grasslands with various mixtures of *Festuca* species, *Agrostis* species, *Holcus lanatus*, *Anthoxanthum odoratum* and *Cynosurus cristatus*, with little or no *Thymus polytrichus*; either herb-rich or species-poor but without small calcicolous forbs and bryophytes 25
- 22 Sparse, open grasslands with *Festuca ovina/vivipara*, *Agrostis capillaris*, *Thymus polytrichus*, *Minuartia verna*, *Thlaspi caerulescens* and usually *Linum catharticum*, *Rumex acetosa*, *R. acetosella* and *Campanula rotundifolia*; on spoil of old lead mines and metalliferous rocks  
*Festuca ovina*-*Minuartia verna* community OV37  
 Grasslands with a denser sward of *Festuca ovina/vivipara*, other grasses and *Thymus polytrichus*, and a range of forbs and sedges, such as *Prunella vulgaris*, *Viola riviniana*, *Alchemilla alpina*, *Linum catharticum* and *Carex pulicaris*, but lacking metallophyte species, such as *Thlaspi caerulescens* or *Minuartia verna* 23
- 23 Grasslands with *Festuca ovina*, *Helictotrichon pratense*, *Briza media*, *Koeleria macrantha*, *Thymus polytrichus*, *Helianthemum nummularium* and lowland forbs, such as *Sanguisorba minor*, *Scabiosa columbaria* and *Carlina vulgaris*; the characteristic upland grassland species *Agrostis capillaris*, *Anthoxanthum odoratum* and *Potentilla erecta* are rare; widespread in the lowlands of north and west England and Wales; scarce in limestone uplands of Wales and north England  
*Festuca ovina*-*Helictotrichon pratense* grassland, *Dicranum scoparium* sub-community CG2d (Note: this vegetation type has virtually the same species composition as the south-western *Festuca ovina*-*Carlina vulgaris* grassland, *Koeleria macrantha* sub-community CG1e)  
 Grasslands with *Festuca ovina/vivipara*, *Agrostis capillaris*, *Anthoxanthum odoratum*, *Thymus polytrichus* and *Potentilla erecta*; lowland forbs, such as *Sanguisorba minor*, *Scabiosa columbaria* and *Carlina vulgaris*, are generally absent; *Helictotrichon pratense*, *Briza media* and *Helianthemum nummularium* are generally rare but may be locally common, for example in the Breadalbanes where they grow in the company of northern and upland species 24
- 24 Grasslands with *Festuca ovina/vivipara*, *Agrostis capillaris*, *Anthoxanthum odoratum*, *Thymus polytrichus* and many small forbs, such as *Plantago lanceolata*, *Prunella vulgaris*, *Viola riviniana* and *Trifolium repens*; in damper stands, *Carex pulicaris*, *C. panicea*, *Linum catharticum* and *Selaginella selaginoides* may be present; *Alchemilla alpina* is usually scarce or absent, and is never abundant  
*Festuca ovina*-*Agrostis capillaris*-*Thymus polytrichus* grassland CG10  
 Grasslands with *Festuca ovina/vivipara*, *Agrostis capillaris*, *Anthoxanthum odoratum*, abundant *Alchemilla alpina*, and many small mesotrophic species, such as *Thymus polytrichus*, *Selaginella selaginoides*, *Ranunculus acris* and *Carex pulicaris*  
*Festuca ovina*-*Agrostis capillaris*-*Alchemilla alpina* grassland CG11
- 25 Grassland dominated by *Agrostis curtisii*, with *Potentilla erecta*, *Festuca ovina* and sprigs of *Calluna vulgaris*; in south-west England and south Wales  
*Agrostis curtisii* grassland U3  
 Grassland dominated by *Festuca* species, *Agrostis* species, *Holcus lanatus*, *Anthoxanthum odoratum* or *Cynosurus cristatus* but not *Agrostis curtisii* 26

- 26 Lush, species-poor grasslands dominated by *Holcus lanatus* and/or *Festuca rubra*, with *Anthoxanthum odoratum*, *Poa pratensis*, *Dactylis glomerata*, *Trifolium repens*, *Plantago lanceolata*, and a sparse layer of mosses including *Scleropodium purum* and *Rhytidiadelphus squarrosus*; on neglected crofts at low altitudes in the Hebrides and in meadows throughout the upland fringes; not described in the NVC  
*Festuca rubra-Holcus lanatus-Anthoxanthum odoratum* grassland (Rodwell *et al.* 1998)  
 Grasslands not dominated by *Holcus lanatus* or *Festuca rubra*; sward with mixtures of *Festuca* species, *Agrostis* species, *Anthoxanthum odoratum* and in some places *H. lanatus* and *Cynosurus cristatus*; varying from species-poor to species-rich with mesotrophic species  
 27
- 27 Grasslands with *Festuca ovina/vivipara*, *Agrostis capillaris*, *A. canina* and *Anthoxanthum odoratum*; *Aira praecox* or small forbs, such as *Galium saxatile* and *Potentilla erecta*, can be very common in the sward; mostly species-poor and lacking mesotrophic herbs  
 28
- Herb-rich grassland with a mixed sward of grasses and a rich array of mesotrophic forbs  
 29
- 28 Short and rather open swards of *Festuca ovina*, *Agrostis capillaris*, *Aira praecox*, *Rumex acetosella* and *Galium saxatile* on thin stony soils on dry sun-exposed slopes  
***Festuca ovina-Agrostis capillaris-Rumex acetosella* grassland, *Galium saxatile-Potentilla erecta* sub-community U1e**  
 Short to medium, more or less dense grasslands with *Festuca* species, *Agrostis* species, *Anthoxanthum odoratum*, *Potentilla erecta*, *Galium saxatile* and varied mixtures of pleurocarpous mosses or *Racomitrium lanuginosum*  
***Festuca ovina-Agrostis capillaris-Galium saxatile* grassland U4**
- 29 Swards of *Festuca ovina*, *F. rubra*, *Agrostis capillaris*, *A. canina* and *Anthoxanthum odoratum* with *Potentilla erecta*, *Galium saxatile*, a deep carpet of pleurocarpous mosses, and a rich flora of mesotrophic forbs, such as *Ranunculus acris*, *Geum rivale*, *Filipendula ulmaria*, *Cirsium heterophyllum* and *Angelica sylvestris*  
**herb-rich form of *Festuca ovina-Agrostis capillaris-Galium saxatile* grassland U4**  
 Less mossy swards of *Festuca* species and *Agrostis* species with *Cynosurus cristatus*, *Holcus lanatus*, *Dactylis glomerata* and mesotrophic forbs, such as *Trifolium pratense*, *Ranunculus acris* and *Rumex acetosa*; *Galium saxatile* scarce or absent  
 30
- 30 Wet herb-rich grasslands with much *Caltha palustris* and commonly with *Carex nigra* and forbs, such as *Ranunculus* species, *Trifolium* species and *Filipendula ulmaria*, in a sward of *Holcus lanatus*, *Festuca rubra*, *Anthoxanthum odoratum*, *Cynosurus cristatus*, *Poa trivialis* and *Agrostis* species  
***Cynosurus cristatus-Caltha palustris* grassland MG8**  
 Drier grasslands with little or no *Caltha palustris*  
 31
- 31 Herb-rich grasslands with much *Geranium sylvaticum* and *Alchemilla* species, and in some places with *Geum rivale*, *Trollius europaeus* and *Cirsium heterophyllum*; in upland meadows and on riversides; locally common in northern England and scattered in Scotland  
***Anthoxanthum odoratum-Geranium sylvaticum* grassland MG3**  
 Grasslands with little or no *Geranium sylvaticum*, but much *Cynosurus cristatus*, *Plantago lanceolata*, *Centaurea nigra*, *Lotus corniculatus*, *Trifolium pratense*, *Rhinanthus minor* and *Ranunculus acris*; scattered through the uplands  
***Cynosurus cristatus-Centaurea nigra* grassland MG5**

## 2.6. Key to rush- and sedge-heaths

Vegetation dominated by *Carex bigelowii*, *Juncus squarrosus* or *J. trifidus*

- 1 Swards dominated by *Carex bigelowii* with *Dicranum fuscescens*, *Racomitrium lanuginosum* or *Polytrichum alpinum* and other montane species, on high plateaux and ridges in the Highlands  
***Carex bigelowii*-*Polytrichum alpinum* sedge-heath U8**  
Swards dominated by *Juncus squarrosus* or *J. trifidus* 2
- 2 Swards dominated by *Juncus squarrosus* 3  
Open swards dominated by *Juncus trifidus* 4
- 3 Swards with *Juncus squarrosus*, in some places damp with *Sphagna*, in other places drier with mixtures of *Festuca ovina*, *Nardus stricta* and other grasses; the vegetation can be dotted with *Vaccinium myrtillus* or *Calluna vulgaris*; less commonly it can be herb-rich with *Ranunculus acris*, *Thalictrum alpinum* and *Trollius europaeus*  
***Juncus squarrosus*-*Festuca ovina* grassland U6**  
Blanket bog with much *Juncus squarrosus*, *Rhytidiadelphus loreus* and *Calluna vulgaris*, and also bog species such as *Erica tetralix*, *Narthecium ossifragum*, *Eriophorum* species and *Sphagnum papillosum*  
***Trichophorum cespitosum*-*Eriophorum vaginatum* blanket mire, *Juncus squarrosus*-*Rhytidiadelphus loreus* sub-community M17c**
- 4 Open swards of *Juncus trifidus*, *Carex bigelowii* and *Racomitrium lanuginosum*, together with other montane species and commonly with abundant lichens; on stony soils on high ridges and summits in the eastern and northern Highlands  
***Juncus trifidus*-*Racomitrium lanuginosum* rush-heath U9**  
Very open swards of *Juncus trifidus*, *Festuca vivipara* and a few other species, such as *Salix herbacea*, *Racomitrium lanuginosum*, *Ochrolechia frigida* and *Polytrichum alpinum*; on stony, wind-blasted but firm soils on exposed ridges in the western Highlands  
***Carex bigelowii*-*Racomitrium lanuginosum* moss heath, species-poor form of the *Silene acaulis* sub-community U10c**

## 2.7. Key to swamps and fens

Vegetation of standing water or very wet ground, dominated by sedges, *Phragmites australis*, *Phalaris arundinacea*, *Equisetum fluviatile* or *Eleocharis palustris* and commonly with tall forbs; mires dominated by *Filipendula ulmaria* and *Iris pseudacorus* are closely related to these swamps and fens, but are keyed out under tall-herb and dwarf-herb vegetation

- 1 Swamps dominated by *Eleocharis palustris* **Eleocharis palustris swamp S19**  
Swamps and fens dominated by other species **2**
- 2 Swamps dominated by *Equisetum fluviatile* **Equisetum fluviatile swamp S10**  
Swamps and fens dominated by other species **3**
- 3 Swamps and fens dominated by *Phragmites australis*, or in some places by *Eriophorum angustifolium*, with tall mesotrophic forbs **4**  
Swamps dominated by *Carex* species, *Phalaris arundinacea* or *Scirpus lacustris* **5**
- 4 Swamps with *Phragmites australis* either totally dominant or with a sparse array of lowland tall herbs, *Galium palustre*, *Mentha aquatica* or maritime species; widespread at low altitudes **Phragmites australis swamp S4**  
Fens dominated by *Phragmites australis* or *Eriophorum angustifolium*, with a moderately rich assemblage of other species, including *Carex rostrata*, *Potentilla palustris*, *Menyanthes trifoliata*, *Angelica sylvestris*, *Lythrum salicaria* and *Lysimachia vulgaris* **Carex rostrata-Potentilla palustris tall-herb fen, Lysimachia vulgaris sub-community S27b**
- 5 Swamps or fens dominated by *Phalaris arundinacea*; widespread in the lowlands and scattered at low altitudes in upland areas **Phalaris arundinacea fen S28**  
Swamps or fens dominated by other species **6**
- 6 Swamps dominated by *Scirpus lacustris* in water more than 25 cm deep; throughout the lowlands but also, less commonly, in the uplands **Scirpus lacustris ssp. lacustris swamp S8**  
Swamps and fens dominated by *Carex* species **7**
- 7 Swamps dominated by *Carex paniculata*; mainly in the lowlands but scattered at low altitudes in upland areas **Carex paniculata swamp S3**  
Swamps not dominated by *Carex paniculata* **8**
- 8 Swamps dominated by *Carex vesicaria*, either in pure swards or with a few other species (but *not* including *C. rostrata* or *Menyanthes trifoliata*) **Carex vesicaria swamp, Carex vesicaria sub-community S11a and Mentha aquatica sub-community S11b**  
Swamps and fens dominated by other *Carex* species, or if by *C. vesicaria* then with a well-developed understorey of forbs and other sedges, including *C. rostrata* **9**
- 9 Swamps and fens dominated by *Carex rostrata* **10**  
Mixtures of *Carex rostrata*, *Potentilla palustris*, *Menyanthes trifoliata*, *Equisetum fluviatile* and *Eriophorum angustifolium*, in some places with much *C. vesicaria*, *C. aquatilis* or *Phragmites australis* **Phragmites australis swamp, Menyanthes trifoliata sub-community S4c**  
**Carex rostrata swamp, Menyanthes trifoliata-Equisetum fluviatile sub-community S9b**  
**Equisetum fluviatile swamp, Carex rostrata sub-community S10b**  
**Carex vesicaria swamp, Carex rostrata sub-community S11c**  
**Carex rostrata-Potentilla palustris tall-herb fen, Carex rostrata-Equisetum fluviatile sub-community S27a**  
(these NVC types converge to such an extent that it is often not possible to separate them)
- 10 *Carex rostrata* dominant in a thin and very species-poor sward in shallow water

**Carex rostrata swamp, Carex rostrata sub-community S9a**

*Carex rostrata* swamps and fens with much *Potentilla palustris* and *Menyanthes trifoliata*

**Carex rostrata swamp, Menyanthes trifoliata-Equisetum fluviatile sub-community S9b**

**Carex rostrata-Potentilla palustris tall-herb fen, Carex rostrata-Equisetum fluviatile sub-community S27a**

(these NVC types converge to such an extent that it is often not possible to separate them)

## 2.8. Key to soligenous mires and rush-pastures

Vegetation of wet, flushed ground, usually dominated by sedges or rushes

- 1 Mires or wet pastures with a moss layer dominated by *Sphagna* or with a sparse sward of vascular plants on bare wet peat 2  
Mires and wet pastures with bryophytes other than *Sphagna* dominant in the ground layer, although a few mesotrophic *Sphagna* may occur; the most common bryophytes are generally *Calliergonella cuspidata*, *Calliergon* species, *Rhizomnium punctatum*, *Bryum pseudotriquetrum*, *Campylium stellatum*, *Scorpidium scorpioides* and *Drepanocladus revolvens* 14
- 2 Springs, rills and soakways dominated by small forbs, such as *Montia fontana*, *Chrysosplenium oppositifolium*, *Ranunculus omiophyllus*, *Hypericum elodes* and *Potamogeton polygonifolius*, usually with *Sphagnum denticulatum* and in some places other bryophytes 3  
Mires dominated by sedges, rushes, *Molinia caerulea*, *Eriophorum angustifolium* or *Trichophorum cespitosum*, or with an open canopy of dwarf shrubs including *Erica tetralix*, *Myrica gale* and *Calluna vulgaris* 5
- 3 Vegetation consisting of dense mats of *Hypericum elodes*, *Potamogeton polygonifolius*, *Ranunculus flammula*, *Hydrocotyle vulgaris*, *Sphagnum denticulatum* and in some places *Carex panicea* and *C. viridula* ssp. *oedocarpa*; at low altitudes in the west  
**Hypericum elodes-Potamogeton polygonifolius soakway M29**  
Vegetation with *Montia fontana* and either *Chrysosplenium oppositifolium* or *Ranunculus omiophyllus* 4
- 4 Vegetation with a thick mat of *Montia fontana* and/or *Chrysosplenium oppositifolium*, together with species such as *Agrostis canina*, *Epilobium palustre*, *Caltha palustris* and mosses, such as *Philonotis fontana*, *Dicranella palustris* and *Sphagnum denticulatum*; in some places with a few montane species, such as *Saxifraga stellaris* and *Epilobium alsinifolium*; with a predominantly upland and northern distribution, usually above 400 m  
**Philonotis fontana-Saxifraga stellaris spring M32**  
Vegetation with *Montia fontana*, *Ranunculus omiophyllus*, *R. flammula*, *Agrostis stolonifera*, *Juncus bulbosus* and *Sphagnum denticulatum* but no montane species; with a predominantly lowland and southern distribution, usually below 450 m  
**Ranunculus omiophyllus-Montia fontana rill M35**
- 5 Mires dominated by *Carex rostrata* 6  
Mires dominated by other sedges, including *Eriophorum angustifolium*, or by rushes, or with a sparse array of dwarf shrubs, such as *Erica tetralix*, *Calluna vulgaris* and *Myrica gale* together with *Molinia caerulea* and/or *Trichophorum cespitosum* 8
- 6 Species-poor *Carex rostrata* mires with a thin sward of *C. rostrata* over a layer of *Sphagnum fallax*, *S. palustre* and *Polytrichum commune*  
**Carex rostrata-Sphagnum fallax mire M4**  
*Carex rostrata* mires with a ground layer of more mesotrophic *Sphagna*, such as *S. squarrosum*, *S. teres* or *S. warnstorffii*, and with some mesotrophic herbs in the sward 7
- 7 Moderately species-rich *Carex rostrata* mires with species such as *Potentilla palustris*, *C. nigra*, *Eriophorum angustifolium* and *Succisa pratensis* over a layer of *Sphagnum squarrosum* or *S. teres*; other mesotrophic herbs may also occur; widely distributed in north and west Britain  
**Carex rostrata-Sphagnum squarrosum mire M5**  
Moderately species-rich *Carex rostrata* mires with species such as *Viola palustris*, *Potentilla erecta*, *Selaginella selaginoides* and *Epilobium palustre* over a ground layer with *Sphagnum warnstorffii*, *S. teres*, *Rhizomnium pseudopunctatum* and *Aulacomnium palustre*; montane species, such as *Thalictrum alpinum* and *Persicaria vivipara*, may be present; rare in the central Highlands, northern England and north Wales  
**Carex rostrata-Sphagnum warnstorffii mire M8**
- 8 Bog pools or flushed channels in bogs, usually with large amounts of *Eriophorum angustifolium*; *Erica tetralix*, *Calluna vulgaris*, *Myrica gale* and *Molinia caerulea* can occur 9  
Mires or wet pastures dominated by sedges or rushes

- 9 Bog pools or flushed channels dominated by *Eriophorum angustifolium*, or bare spreads of peat on which *E. angustifolium* is the most abundant species  
***Eriophorum angustifolium* bog pool M3**  
 Flushed channels within blanket bog or wet heath, with mixtures of *Eriophorum angustifolium*, *Erica tetralix*, *Carex panicea*, *Trichophorum cespitosum*, *Molinia caerulea*, *Myrica gale*, *Sphagnum denticulatum*, *Campylopus atrovirens*, *Breutelia chrysocoma* and in many places *Drosera* species; *Molinia caerulea* and *Myrica gale* can be dominant; *Schoenus nigricans* can occur at low altitudes in the western Highlands  
***Trichophorum cespitosum*-*Erica tetralix* wet heath, *Carex panicea* sub-community M15a**
- 10 Mires dominated by sedges 11  
 Mires dominated by rushes 13
- 11 Mires dominated by *Carex panicea* and *Carex viridula* ssp. *oedocarpa* with *Potamogeton polygonifolius*; in peaty soakways  
***Hypericum elodes*-*Potamogeton polygonifolius* soakway M29 (species-poor form without *H. elodes*)**  
 Mires dominated by *Carex echinata*, *C. nigra* and other small sedges, in some places with *C. curta* and *Eriophorum angustifolium* 12
- 12 Mires with mixtures of *Carex echinata*, *C. nigra* and other small sedges, and with a ground layer of *Sphagnum fallax*, *S. denticulatum*, *S. palustre* and *Polytrichum commune*; common at low to moderate altitudes throughout the uplands  
***Carex echinata*-*Sphagnum fallax*/*S. denticulatum* mire, *Carex echinata* sub-community M6a and *Carex nigra*-*Nardus stricta* sub-community M6b**  
 Mires with small sedges, such as *Carex echinata*, *C. nigra*, *Eriophorum angustifolium* and commonly *C. curta*, with a ground layer of *Sphagnum denticulatum*, *S. papillosum*, *S. russowii* and in some stands *S. lindbergii*, and a scattering of montane species, such as *C. bigelowii*, *Saxifraga stellaris* and *Festuca vivipara*; at moderate to high altitudes from the Lake District northwards  
***Carex curta*-*Sphagnum russowii* mire M7**
- 13 Mires dominated by *Juncus effusus* over a ground layer of *Sphagnum fallax*, *S. denticulatum*, *S. palustre* and *Polytrichum commune*  
***Carex echinata*-*Sphagnum fallax*/*S. denticulatum* mire, *Juncus effusus* sub-community M6c**  
 Mires dominated by *Juncus acutiflorus* over a ground layer of *Sphagnum fallax*, *S. denticulatum*, *S. palustre* and *Polytrichum commune*  
***Carex echinata*-*Sphagnum fallax*/*S. denticulatum* mire, *Juncus acutiflorus* sub-community M6d**
- 14 Wet pastures or extensive mires dominated by rushes mixed with grasses and tall forbs 15  
 Mires dominated by sedges with either tall or short forbs, often occurring as small flushes 17
- 15 Wet pastures or mires dominated by *Juncus acutiflorus*, with tall forbs, such as *Angelica sylvestris*, *Filipendula ulmaria*, *Ranunculus acris*, *Lychnis flos-cuculi*, *Mentha aquatica* and *Cirsium palustre*  
***Juncus effusus*/*acutiflorus*-*Galium palustre* rush-pasture, *Juncus acutiflorus* sub-community M23a**  
 Wet pastures or mires dominated by *Juncus effusus* with a range of grasses and tall forbs 16
- 16 Wet pastures with *Juncus effusus*, *Holcus lanatus*, *Agrostis canina*, *Galium palustre* and a few tall forbs, such as *Cirsium palustre*, *Ranunculus flammula*, *Mentha aquatica*, *Angelica sylvestris*, *Viola palustris* and *Hydrocotyle vulgaris*  
***Juncus effusus*/*acutiflorus*-*Galium palustre* rush-pasture, *Juncus effusus* sub-community M23b**  
 Wet pastures with *Juncus effusus*, *Holcus lanatus*, *Agrostis stolonifera* and *Ranunculus repens* together with plants such as *Poa trivialis*, *Ranunculus acris*, *Trifolium repens* and in some places *Rumex obtusifolius* and *Cirsium arvense*; generally lacking fen species, such as *Galium palustre*, *Cirsium palustre* and *Ranunculus flammula*; mainly lowland but extending into the upland fringes  
***Holcus lanatus*-*Juncus effusus* rush-pasture MG10**
- 17 Mires dominated by *Carex rostrata* with much *Eriophorum angustifolium*, *C. nigra*, *C. panicea*, *Menyanthes trifoliata*, *Potentilla palustris*, *Galium palustre* and many other mesotrophic herbs; with a dense underlay of mosses, such as *Calliergonella cuspidata*, *Calliergon giganteum*, *Campylium stellatum*, *Scorpidium scorpioides* and *Bryum pseudotriquetrum*; *Carex diandra* can be very common  
***Carex rostrata*-*Calliergonella cuspidata*/*Calliergon giganteum* mire M9**

- Mires dominated by sedges other than *C. rostrata* 18
- 18 Mires dominated by *Carex saxatilis*, with montane species, such as *Saxifraga stellaris*, *Persicaria vivipara* and *Thalictrum alpinum*, and with a bryophyte layer including *Drepanocladus revolvens*, *Hylocomium splendens*, *Scapania undulata* and *Aneura pinguis*; at high altitudes in the Scottish Highlands, typically where snow lies late  
**Carex saxatilis mire M12**
- Mires dominated by sedges other than *Carex saxatilis* 19
- 19 Mires of small sedges, such as *Carex nigra*, *C. echinata*, *C. panicea*, *C. viridula* ssp. *oedocarpa* and *C. hostiana*, mixed with tall mesotrophic forbs, such as *Ranunculus acris*, *Crepis paludosa*, *Parnassia palustris*, *Geum rivale* and *Filipendula ulmaria*, and bryophytes, such as *Rhizomnium punctatum* and *Calliergonella cuspidata*, or base-tolerant Sphagna (*Sphagnum contortum*, *S. teres*, *S. warnstorffii* and *S. squarrosum*)  
Herb-rich small-sedge mire (see p xxx)
- Mires of small sedges, such as *Carex dioica*, *C. panicea* and *C. viridula* ssp. *oedocarpa*, with small forbs, including *Potamogeton polygonifolius*, *Pinguicula vulgaris* and *Saxifraga* species, and mosses, such as *Campylium stellatum*, *Scorpidium scorpioides*, *Drepanocladus revolvens* and *Blindia acuta*; tall forbs and base-tolerant Sphagna scarce or absent 20
- 20 Mires with an open sward of *Carex panicea* and *C. viridula* ssp. *oedocarpa* with much *Potamogeton polygonifolius* in peaty soakways  
**Hypericum elodes-Potamogeton polygonifolius soakway M29 (species-poor form without H. elodes)**
- Mires with *Carex panicea* and *C. viridula* ssp. *oedocarpa* but without *Potamogeton polygonifolius* and in many places with a rich flora of small calcicolous sedges and forbs; can have a noticeable sulphurous smell of decomposing vegetation 21
- 21 Rather sparse open mires of *Carex panicea*, *C. viridula* ssp. *oedocarpa*, *C. dioica*, *C. pulicaris*, *Pinguicula vulgaris* and *Selaginella selaginoides*, with tufts and clumps of mosses, such as *Campylium stellatum*, *Drepanocladus revolvens*, *Scorpidium scorpioides* and *Blindia acuta*; *Saxifraga aizoides* scarce or absent, and other montane species usually not common; *Schoenus nigricans* is common in some stands; there can be a strong smell of decomposing vegetation  
**Carex dioica-Pinguicula vulgaris mire M10**
- Open and usually stony mires with *Carex panicea*, *C. viridula* ssp. *oedocarpa* and *Saxifraga aizoides*, typically with montane species, such as *Juncus triglumis*, *Alchemilla alpina*, *Persicaria vivipara* and *Saxifraga stellaris*, and bryophytes, including *Campylium stellatum*, *Drepanocladus revolvens*, *Blindia acuta* and *Aneura pinguis* 22
- 22 Flushes with *Koenigia islandica* evident during the spring to autumn months; *Saxifraga aizoides* common but can be absent; on basalt plateaux on Mull and Skye  
**Carex viridula ssp. oedocarpa-Koenigia islandica flush M34**
- Mires without *Koenigia islandica* but mostly with *Saxifraga aizoides* except in north Wales  
**Carex viridula ssp. oedocarpa-Saxifraga aizoides mire M11**

## 2.9. Key to fern communities

Vegetation dominated by ferns

- 1 Open communities on rocky substrates, including boulder fields, screes, limestone pavements and crevices in cliffs and walls, with abundant small to medium-sized ferns, such as *Asplenium* species, *Gymnocarpium robertianum* or *Cryptogramma crispa* 2

Denser communities on soil or on larger cliff ledges, dominated by large ferns, such as *Pteridium aquilinum*, *Oreopteris limbosperma* or *Dryopteris* species 6
- 2 Short open vegetation of rock crevices, dominated by *Asplenium* species 3

Taller communities dominated by other species 4
- 3 Assemblages of *Asplenium trichomanes*, *A. ruta-muraria*, *Festuca ovina*, *Thymus polytrichus* and the bryophytes *Homalothecium sericeum*, *Hypnum cupressiforme* s.l. and *Fissidens dubius*; in crevices of base-rich rocks and on mortared walls, in the lowlands and to moderate altitudes in the hills
 

***Asplenium trichomanes-Asplenium ruta-muraria* community OV39**

 Assemblages of *Asplenium viride*, *A. ruta-muraria*, *A. trichomanes* and *Cystopteris fragilis*, with *Ctenidium molluscum*, *Fissidens dubius* and *Tortella tortuosa*; in shaded crevices and on rock ledges in the uplands
 

***Asplenium viride-Cystopteris fragilis* community OV40**
- 4 Vegetation dominated by *Gymnocarpium robertianum*; with tall tufts of *Arrhenatherum elatius*, sprawling plants of *Geranium robertianum*, and scattered *Teucrium scorodonia*; on limestone pavement and scree in southern Britain
 

***Gymnocarpium robertianum-Arrhenatherum elatius* community OV38**

 Vegetation of scree or boulder fields with *Cryptogramma crispa* and no *Gymnocarpium robertianum* 5
- 5 Mixtures of *Cryptogramma crispa*, *Athyrium distentifolium*, *Dryopteris dilatata* and *D. oreades* growing in mats of humus with *Deschampsia cespitosa*, montane plants, such as *Alchemilla alpina* and *Saxifraga stellaris*, and bryophytes, including *Barbilophozia floerkei*, *Rhytidiadelphus loreus*, *Polytrichum alpinum* and *Kiaeria starkei*; in boulder fields on sheltered high slopes and in corries where snow lies late in spring
 

***Cryptogramma crispa-Athyrium distentifolium* snow-bed U18**

 Vegetation with *Cryptogramma crispa*, *Deschampsia flexuosa*, *Festuca ovina*, *Galium saxatile*, *Campylopus flexuosus*, *Polytrichum formosum* and few or no montane species; on scree and boulders on sub-montane slopes
 

***Cryptogramma crispa-Deschampsia flexuosa* community U21**
- 6 Vegetation dominated by *Pteridium aquilinum* 7

Vegetation dominated by *Oreopteris limbosperma* or *Dryopteris* species 8
- 7 Stands of bracken with a species-poor ground flora which is either grassy, resembling a short mossy *Festuca-Agrostis-Galium* grassland U4, heathy with *Vaccinium myrtillus* and/or *Calluna vulgaris*, or almost absent due to the presence of a deep mat of bracken litter
 

***Pteridium aquilinum-Galium saxatile* community U20**

 Stands of bracken, many of which have *Rubus fruticosus* and a species-rich ground flora, either with woodland forbs, such as *Hyacinthoides non-scripta*, *Primula vulgaris*, *Mercurialis perennis* and *Stachys sylvatica*, with *Teucrium scorodonia*, or with species of damp ground, such as *Filipendula ulmaria*, *Geum rivale*, *Lysimachia nemorum*, *Carex panicea* and *C. pulicaris*

***Pteridium aquilinum-Rubus fruticosus* underscrub W25**
- 8 Fern communities dominated by *Dryopteris dilatata*, *D. filix-mas* or *D. affinis*, together with *Luzula sylvatica*, *Vaccinium myrtillus*, *Deschampsia cespitosa*, *Oxalis acetosella*, *Dicranum scoparium* and *D. majus*; on cliff ledges or steep slopes
 

***Luzula sylvatica-Vaccinium myrtillus* tall-herb community, *Dryopteris dilatata-Dicranum majus* sub-community U16a**

 Fern communities dominated by *Oreopteris limbosperma* or *Dryopteris affinis* with little or no *Luzula sylvatica* 9
- 9 Fern communities dominated by *Oreopteris limbosperma* with a little *Blechnum spicant* and a grassy field layer with *Potentilla erecta*, *Galium saxatile* and *Oxalis acetosella*

***Oreopteris limbosperma-Blechnum spicant* community U19**

Fern communities dominated by *Dryopteris affinis* and with species such as *Galium saxatile*, *Potentilla erecta* and pleurocarpous mosses; on rocky banks and lower hill slopes  
*Dryopteris affinis* provisional community (Rodwell *et al.* 1998)

## 2.10. Key to tall-herb and dwarf-herb vegetation

Vegetation dominated by either short or tall herbs

- 1 Short vegetation made up of small forbs 2  
 Tall vegetation dominated by larger herbaceous species 6
- 2 Open vegetation on dripping cliffs and rock faces, with *Saxifraga aizoides*, *S. oppositifolia*, *Selaginella selaginoides*, *Alchemilla glabra*, *A. alpina*, *Thalictrum alpinum* and a rich array of calcicolous bryophytes  
***Saxifraga aizoides*-*Alchemilla glabra* banks U15**  
 Open to dense vegetation on drier substrates, without abundant *Saxifraga* species 3
- 3 Open, greyish, species-poor swards with much *Minuartia verna* and in many places with *Thlaspi caerulescens* and other small plants, such as *Campanula rotundifolia*, *Linum catharticum*, *Rumex acetosa* and *R. acetosella*; on the spoil of lead mines and on veins of metalliferous rock  
***Festuca ovina*-*Minuartia verna* community OV37**  
 Short, herb-rich swards with a greater diversity of forbs and bryophytes and without metallophyte species, such as *Minuartia verna* and *Thlaspi caerulescens*; in snow-beds and on high slopes and summits 4
- 4 Rather sparse silvery-green mats of *Alchemilla alpina*, *Sibbaldia procumbens*, *Carex bigelowii*, *Polytrichum alpinum* and other small montane plants set in a mat of *Racomitrium* species, especially *R. fasciculare*; on high shaded slopes where snow lies late in the Scottish Highlands; there are similar-looking assemblages of *Alchemilla alpina* and *Potentilla erecta* (but lacking *Sibbaldia*) in comparable habitats in the Lake District and the western Highlands  
***Alchemilla alpina*-*Sibbaldia procumbens* dwarf-herb community U14**  
 Species-rich and usually greener-coloured swards of small plants including *Silene acaulis*, *Minuartia sedoides*, *Persicaria vivipara*, *Ranunculus acris*, *Thymus polytrichus* and *Alchemilla alpina* on high slopes and ridges 5
- 5 Swards of *Silene acaulis*, *Minuartia sedoides*, *Thymus polytrichus*, *Alchemilla alpina*, *Persicaria vivipara*, *Festuca vivipara*, *Deschampsia cespitosa*, *Selaginella selaginoides* and other small plants, many of them calcicoles; with mosses, such as *Racomitrium lanuginosum*, *Hylocomium splendens*, *Pleurozium schreberi* and *Hypnum lacunosum*; grasses and bryophytes are subordinate to the dwarf herbs; on high slopes and beneath cliffs, including places where snow lies moderately late  
***Festuca ovina*-*Alchemilla alpina*-*Silene acaulis* dwarf-herb community CG12**  
 Mossy swards of *Racomitrium lanuginosum* and *Carex bigelowii* with dwarf herbs, such as *Silene acaulis*, *Minuartia sedoides*, *Armeria maritima*, *Ranunculus acris* and *Persicaria vivipara*, and also *Salix herbacea* and *Thymus polytrichus*; can be very herb-rich but looks more like a moss-heath with herbs than a dwarf-herb sward; on summits and high ridges which are blown clear of snow in winter  
***Carex bigelowii*-*Racomitrium lanuginosum* moss-heath, species-rich form of the *Silene acaulis* sub-community U10c**
- 6 Weedy vegetation dominated by *Urtica dioica*, mostly on disturbed ground 7  
 Vegetation of less-modified habitats dominated by *Iris pseudacorus*, *Caltha palustris* or varied mixtures of tall forbs, *Luzula sylvatica*, *Vaccinium myrtillus* and ferns 8
- 7 Dense beds of *Urtica dioica*, *Galium aparine*, *Poa trivialis*, *Arrhenatherum elatius* and in some places tall forbs, such as *Anthriscus sylvestris* and *Heracleum sphondylium*; common throughout the lowlands; also in upland districts on disturbed ground around buildings, along roads and beside walls, and on the strandline  
*Urtica dioica*-*Galium aparine* community OV24  
 Patchy stands of *Urtica dioica* dotted with *Cirsium arvense*, *C. vulgare* and grasses, such as *Elymus repens*, *Holcus lanatus*, *Dactylis glomerata*, *Arrhenatherum elatius* and *Lolium perenne*; common throughout the lowlands; also occurs at low altitudes in upland areas on disturbed ground around buildings, on roadsides and on molehills or eutrophicated soil in pastures  
*Urtica dioica*-*Cirsium arvense* community OV25
- 8 Dense swards of *Iris pseudacorus* with *Oenanthe crocata*, *Filipendula ulmaria*, *Poa trivialis* and species such as *Juncus effusus*, *J. acutiflorus*, *Rumex acetosa*, *Ranunculus acris*, *Galium* species, *Urtica dioica* and *Cirsium* species; some stands contain maritime species; along the shore, in wet hollows on raised beaches, and extending a few miles inland at low altitudes; mainly in the western Highlands and Hebrides

- Iris pseudacorus-Filipendula ulmaria* mire M28**
- Tall-herb vegetation not dominated by *Iris pseudacorus* 9
- 9 Herb-rich swards of *Caltha palustris* with *Ranunculus* species, *Trifolium* species, *Filipendula ulmaria*, *Carex nigra*, *Anthoxanthum odoratum*, *Holcus lanatus*, *Cynosurus cristatus* and *Festuca rubra*; in unimproved fields in Shetland, north-west Highlands, north Pennines and lowland England and Wales  
***Cynosurus cristatus-Caltha palustris* grassland MG8**
- Vegetation not dominated by *Caltha palustris*; *Caltha* can occur in mixtures with other herbs, but is much less abundant than the other species 10
- 10 Species-poor assemblages of *Luzula sylvatica*, *Vaccinium myrtillus*, grasses and ferns on cliff ledges and lightly-grazed slopes at moderate to high altitudes  
***Luzula sylvatica-Vaccinium myrtillus* tall-herb community U16**
- Dense stands of *Filipendula ulmaria* in level to gently-sloping low-altitude mires, or herb-rich assemblages on steep rocky slopes and dripping ledges with species such as *Alchemilla glabra*, *A. alpina*, *Saxifraga aizoides*, *Luzula sylvatica*, *Sedum rosea*, *Geum rivale* and many sedges and bryophytes 11
- 11 Tall mires or fens dominated by *Filipendula ulmaria*, commonly with *Angelica sylvestris*, *Valeriana officinalis*, *Galium palustre*, *Lychnis flos-cuculi*, *Cardamine pratensis* and *Ranunculus flammula*; on wet soils in low-altitude hollows and valleys, alongside streams, around open water and in wet woodland glades  
***Filipendula ulmaria-Angelica sylvestris* mire M27**
- Tall-herb vegetation on cliff ledges, dripping rocks and steep slopes, with a rich suite of species, including *Filipendula ulmaria*, *Alchemilla glabra*, *A. alpina*, *Saxifraga aizoides*, *Luzula sylvatica*, *Sedum rosea*, *Geum rivale* and many sedges and bryophytes 12
- 12 Open herbaceous vegetation on dripping rock-faces with *Saxifraga aizoides*, *S. oppositifolia*, *Selaginella selaginoides*, *Alchemilla glabra*, *A. alpina*, *Thalictrum alpinum* and many sedges and bryophytes  
***Saxifraga aizoides-Alchemilla glabra* banks U15**
- Mixtures of *Luzula sylvatica*, *Deschampsia cespitosa* and tall forbs, such as *Sedum rosea*, *Angelica sylvestris*, *Geum rivale*, *Trollius europaeus*, *Geranium sylvaticum* and *Alchemilla glabra*; on base-rich ledges and in some places on ungrazed slopes at moderate altitudes; can be extremely species-rich  
***Luzula sylvatica-Geum rivale* tall-herb community U17**

## 2.11. Key to springs, soakways and bog pools

Bryophyte-dominated vegetation of wet habitats

- 1 Pools or very wet depressions in bogs, or soakways among various types of vegetation 2  
 Springheads where water emerges from the ground 6
- 2 Species-poor pools or very wet depressions in bogs; dominated by *Sphagna* 3  
 Soakways among a variety of vegetation types, dominated by bryophytes other than *Sphagna* or by herbs 4
- 3 Bog pools or very wet depressions with abundant *Sphagnum denticulatum* and, in many places, abundant *S. cuspidatum*; with a sparse layer of vascular plants, such as *Eriophorum angustifolium*, *Trichophorum cespitosum*, *Rhynchospora alba* and *Drosera* species; can contain *Menyanthes trifoliata*  
***Sphagnum denticulatum* bog pool community M1**  
 Bog pools or very wet depressions with abundant *Sphagnum cuspidatum* and/or *S. fallax*, and usually lacking *S. denticulatum*; vascular plants include *Erica tetralix* and a few small species, such as *Rhynchospora alba*, *Vaccinium oxycoccos* and *Andromeda polifolia*  
***Sphagnum cuspidatum*/S. *fallax* bog pool community M2**
- 4 Soakways with *Campylopus atrovirens* and a sparse sward of *Narthecium ossifragum*, *Trichophorum cespitosum*, *Carex panicea*, *Nardus stricta* and in some places *Erica tetralix*; within blanket bogs, wet heaths or grasslands at fairly low to moderately high altitudes; *Campylopus shawii* is locally common in the Outer Hebrides and on Skye  
***Trichophorum cespitosum*-*Erica tetralix* wet heath, *Carex panicea* sub-community M15a**  
 More herb-rich soakways without *Erica tetralix*, *Trichophorum cespitosum* and other bog species, but with small herbs, such as *Montia fontana*, *Potamogeton polygonifolius*, *Ranunculus flammula* and sedges, and with mosses, such as *Philonotis fontana* 5
- 5 Soakways with *Hypericum elodes*, *Potamogeton polygonifolius*, *Molinia caerulea*, *Hydrocotyle vulgaris*, *Sphagnum denticulatum* and in many places *Anagallis tenella* and various sedges; can lack *H. elodes* and consist mainly of *P. polygonifolius*, *Carex panicea*, *C. nigra* and *Carex viridula* ssp. *oedocarpa*  
***Hypericum elodes*-*Potamogeton polygonifolius* soakway M29**  
 Soakways with *Ranunculus omiophyllus*, *R. flammula*, *Montia fontana*, *Sphagnum denticulatum* and in many places *Agrostis stolonifera*, *Juncus bulbosus*, *J. articulatus* and *Potamogeton polygonifolius*  
***Ranunculus omiophyllus*-*Montia fontana* rill M35**
- 6 Springheads dominated by *Anthelia julacea* growing in a tight silvery-green mat or cushion studded with *Sphagnum denticulatum*, *Saxifraga stellaris*, *Oligotrichum hercynicum* and other small bryophytes and herbs; generally at high altitudes in places where snow lies late  
***Anthelia julacea*-*Sphagnum denticulatum* spring M31**  
 Springs in which *Anthelia julacea* is not dominant 7
- 7 Springs dominated by *Pohlia wahlenbergii* var. *glacialis*, with a few other species such as *Saxifraga stellaris*, *Deschampsia cespitosa* ssp. *alpina*, *Scapania undulata* and *Pohlia ludwigii*; conspicuous pale apple-green patches at high altitudes in corries and on shaded slopes where snow lies late in the Scottish Highlands  
***Pohlia wahlenbergii* var. *glacialis* spring M33**  
 Springs in which *Pohlia wahlenbergii* var. *glacialis* is not dominant, although the odd tuft may occur in springs at high altitudes 8
- 8 Springs dominated by *Palustriella commutata* or *Cratoneuron filicinum*, with *Bryum pseudotriquetrum*, *Festuca rubra* and small forbs, sedges and grasses; on hills with base-rich rocks 9  
 Springs dominated by species other than *Palustriella commutata* or *Cratoneuron filicinum* 10
- 9 *Palustriella commutata* or *Cratoneuron filicinum* springs with *Festuca rubra*, *Bryum pseudotriquetrum*, *Cardamine pratensis*, *Carex panicea*, *C. flacca* and a few other species; widespread in the uplands  
***Palustriella commutata*-*Festuca rubra* spring M37**  
*Palustriella commutata* or *Cratoneuron filicinum* springs with *Carex nigra*, *Selaginella selaginoides* and a rich flora of small forbs, grasses and sedges, including montane plants, such as *Persicaria vivipara*, *Juncus triglumis*

and *Epilobium anagallidifolium*; at moderate to high altitudes on limestone in northern England and on base-rich rocks in Scotland

***Palustriella commutata*-*Carex nigra* spring M38**

- 10 Springs with *Montia fontana*, *Ranunculus omiophyllus*, *R. flammula*, *Sphagnum denticulatum* and a few small forbs, sedges and grasses; at low to moderate altitudes in the uplands of south-west England, Wales and north-west England

***Ranunculus omiophyllus*-*Montia fontana* rill M35**

Springs dominated by bryophytes, such as *Philonotis fontana*, *Dicranella palustris*, *Sphagnum denticulatum*, *Warnstorfia fluitans*, *W. exannulata*, *Bryum pseudotriquetrum* and *Scapania undulata*; the brightly-coloured patches of bryophytes are dotted with small herbs, such as *Montia fontana*, *Saxifraga stellaris*, *Chrysosplenium oppositifolium*, *Agrostis canina* and *Epilobium* species; at moderate to high altitudes from Wales northwards

***Philonotis fontana*-*Saxifraga stellaris* spring M32**

## 2.12. Key to montane moss-heaths and snow-beds

Bryophyte-dominated vegetation of damp or dry substrates at high altitudes

- 1 Moss-heaths consisting of extensive silvery carpets of *Racomitrium lanuginosum* or rarely *R. ericoides* on exposed summits and high ridges, or predominantly bare patches of stony and wind-blasted ground on very exposed summits, cols and ridges 2

Moss-heaths or liverwort mats not dominated by *Racomitrium lanuginosum* and mostly on steep shaded slopes, in hollows or in gullies at high altitudes where snow lies late 6
- 2 Heaths with much *Nardus stricta*, usually with scattered small plants of other vascular species, such as *Diphasiastrum alpinum*, *Huperzia selago* and *Calluna vulgaris* 6

***Nardus stricta*-*Galium saxatile* grassland, *Racomitrium lanuginosum* sub-community U5e**

*Racomitrium* heaths or predominantly bare wind-blasted stony surfaces with very little or no *Nardus stricta* or *Calluna vulgaris* 3
- 3 Predominantly bare, stony, wind-blasted ground with a sparse sprinkling of plants, almost too open to be called vegetation at all 4

Vegetation with a thick mat of *Racomitrium lanuginosum* or, less commonly, *R. ericoides* over stony summits or ridges or on scree 5
- 4 Sparse open vegetation on wind-blasted summits and ridges at high altitudes with species such as *Juncus trifidus*, *Festuca vivipara*, *Alchemilla alpina*, *Salix herbacea*, *Racomitrium lanuginosum* and, in many places, the lichen *Ochrolechia frigida* 4

***Carex bigelowii*-*Racomitrium lanuginosum* moss heath, species-poor form of the *Silene acaulis* sub-community U10c**

Spreads of fine gravel at moderate to high altitudes with a scattering of species such as *Festuca ovina/vivipara*, *Agrostis canina*, *Vaccinium myrtillus*, *V. vitis-idaea*, *Saxifraga stellaris*, *Campanula rotundifolia*, *Thymus polytrichus*, *Viola riviniana*, *Potentilla erecta*, *Oligotrichum hercynicum* and *Racomitrium ellipticum* 5

Fell-field (see p xxx)
- 5 *Racomitrium* heaths with a speckling of *Carex bigelowii*, *Vaccinium myrtillus*, *Diphasiastrum alpinum*, *Galium saxatile*, *Festuca vivipara* and other small species; *Racomitrium lanuginosum* is generally the dominant species but on some summits around Ben Nevis and perhaps elsewhere there are *R. ericoides* heaths which are otherwise identical; (*R. ericoides* also grows in pure stands on gravel, along tracks and on river shingle at low altitudes; this community was not sampled by the NVC and has no connection with montane moss-heaths, although it looks superficially similar) 4

***Carex bigelowii*-*Racomitrium lanuginosum* moss-heath U10**

Species-poor mats of *Racomitrium lanuginosum* on dry, stable block scree 5

*Racomitrium lanuginosum* scree community (see p xxx)
- 6 Moss-heaths dominated by *Rhytidiadelphus loreus*, commonly with *Hylocomium splendens*, and with a sprinkling of small vascular species, such as *Deschampsia cespitosa*, *Carex bigelowii* and *Vaccinium myrtillus* 6

***Deschampsia cespitosa*-*Galium saxatile* grassland, *Rhytidiadelphus loreus* sub-community U13b**

Moss-heaths and snow-beds dominated by bryophytes other than *Rhytidiadelphus loreus* 7
- 7 Snow-beds dominated by *Racomitrium heterostichum*, *R. fasciculare* or diminutive liverworts 8

Snow-beds dominated by *Kiaeria* species, *Polytrichum sexangulare* or *Pohlia ludwigii* 9
- 8 Patches of *Racomitrium* species, especially *R. fasciculare*, scattered with *Alchemilla alpina*, *Sibbaldia procumbens* and other montane species, such as *Luzula spicata* 8

***Alchemilla alpina*-*Sibbaldia procumbens* dwarf-herb community U14**

Snow-beds consisting either of patches of *Racomitrium heterostichum* with small vascular species, such as *Luzula spicata*, *Silene acaulis*, *Saxifraga stellaris* and *Persicaria vivipara*, or of very low, crusty, blackish-grey patches of tiny liverworts, such as *Gymnomitrium concinatum*, *G. corallioides*, *Marsupella* species, *Nardia breidlerii* and *Anthelia juratzkana*, speckled with *Salix herbacea*, *Gnaphalium supinum*, *Oligotrichum hercynicum* and other small species 9

***Salix herbacea*-*Racomitrium heterostichum* snow-bed U12**

- 9 Snow-beds consisting of mats of *Kiaeria starkei*, *K. blyttii*, *K. falcata* or *Polytrichum sexangulare*, with a few other montane species, such as *Huperzia selago*, *Saxifraga stellaris*, *Anthelia juratzkana* and *Conostomum tetragonum*  
**Polytrichum sexangulare-Kiaeria starkei snow-bed U11**  
Snow-beds dominated by *Pohlia ludwigii* with *Polytrichum sexangulare*, *Deschampsia flexuosa* and *Nardia scalaris*

*Pohlia ludwigii* snow-bed (Rothero 1991) (see *Salix-Racomitrium* snow-bed U12)